Road To The Top

A systematic approach to distance training that produced one of America's greatest running programs

by Coach Joe I. Vigil, Ph.D.

Coach Joe I. Vigil Ph.D.

The consummate coach, educator, motivator, and diplomat. The legacy he leaves, his record, provides true insight of this truly compassionate individual.

This record reveals that not only is he a master of his sport, but as a champion of wisdom and understanding as well. He has legitimized the term Philosopher - Coach.

His activities have made a lasting impact, not only in the world of sports but in the field of teaching, planning, and international relations among coaches and organizations.

Coach Vigil would certainly have been at home in the company of the ancient sages as well as modern day leaders and scholars.

Both he and his teams have been honored by university Boards of Trustees, statelegislatures, national and international federations. He personally is a member of four halls of fame and is the only American to have ever been inducted into the Lasse Viren Foundation.

His record will remain as a challenge to those who come behind him and serve as a model for those that dare to dedicate and commit themselves for the welfare of youth.

The complexity of this philosopher - coach is a study in competitive zeal and dedication. He has demonstrated a fiery passion for his work and an unflagging commitment to excellence. He has set a standard in combining relentless force and intellectual integrity.

And so **the record of Coach Vigil** "One of the most successful in the history of collegiate sports in America."

17-time international coach which included involvement in world competitions such as:
- The Olympic Games
- The World Championships
- The World University Games
- The Pan-American Games
- The World Cross Country Championships

The only American coach invited to lecture and give clinics in all five continents of the world. Considered by many as one of the western hemispheres best clinicians of physiology and track and field.

Fourteen-time National Coach of the Year in both track and field and cross country.

19 national championships
- 14 cross country
- 2 track and field
- 3 Junior TAC Cross County Championships

The highest number of national championships any one coach has won in the annals of collegiate athletics.

His teams have produced
- 350 All Americans
- 87 Individual National Champions
- 12 Team National Records
- 12 Individual National Records

His won loss record for 29 years stands at 3013 wins against 176 losses and 2 ties for a 94.2% won and 5.8% loss record.
The highest win percentage ever recorded by a single collegiate sport.

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by
Coach Joe I. Vigil, Ph.D.

To Jim,
A great Friend and
A great Coach.
Best Wishes and lots of
Luck in All Your endeavors.
Remember The good old days
At ASC.
Coach Joe Vigil

Creative Designs, Inc.
Albuquerque, New Mexico

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(l-r) Phillip Castillo, Peter de le Cerda, Dave Brooks, Jason Mohr and Paul Stoneham.
On November 21, 1992 the Adams State Harriers of Dr. Joe I. Vigil stepped into the NCAA spotlight and accomplished something no other team had done in the history of Cross Country National Championship events. The green and gold clad young men crossed the finish line in Slippery Rock, PA just 4 seconds apart to post a perfect score of 15 points. Dating back to the beginning of NCAA cross country in 1938, it was a feat that had never been done before. It stands as one bright shinning moment in the history of U.S. Cross Country. We may never see the likes of it again. — Lloyd Engen

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Acknowledgments

This book owes its substance to everyone with whom I have come in contact as a coach and as a teacher. I am particularly indebted to the following:

To the athletes I have had the privilege of coaching for allowing me to apply the theory and practice that I believe in.

To the Sports Information Director at Adams State College, Lloyd Engen, for the gracious manner in which he made our team and program known worldwide.

To the citizens of Alamosa and the San Luis Valley who developed an ownership in the program with their emotional and financial support over the years.

To Alecia and Jonathan Dailey for their devotion and perseverance in completing and publishing this book.

To All - I express my most sincere gratitude.

Joe I. Vigil

Foreword

When Dr. Joe Vigil asked me to write this foreword I was thrilled and honored. I also knew this would be an awesome responsibility . . .just how do you describe the essence of a man of legendary status? I intend to do my very best to allow the reader to see what Dr. Joe and his book, ***Road To The Top***, are all about.

Let me begin by saying I have known Joe Vigil for some fifteen years. We were introduced by Dick Ulrich, a former York High School coach, who was then working with Joe at Adams State College. Dick said many times that he just had to get Joe and I together because we were so much alike that he knew we would hit it off together. . . and how right he was!

Joe Vigil is my friend, my mentor, my teacher, my leader, my motivator and above all, my hero! Perhaps this anecdote will give you some insight into our relationship: As Joe lectures all over the world, he tells this story about our first meeting, and I quote, "From the moment I first set eyes on Joe Newton, I knew I was going to have to begin to lift some very heavy weights . . . because I knew I was going to have to *carry* him for the rest of my life." A very prophetic statement.

When you think about the greatest track coaches of modern times, thoughts are naturally drawn to names such as Arthur Lydiard, Pearcy Cerutty, Mihalyi Igloi, Bill Bowerman, Peter Coe and Franz Stampl. I submit Dr. Joe Vigil must be added to that list . . . he is a legend in his own time.

In Alamosa, Colorado (the home of Adams State), his name is a household word. And why not?? His teams have won 19 National Championships. He has had so many All American runners that he has lost count. In 1992, he reached the ultimate in coaching . . . in winning the National Cross Country Championship that year, Adams State achieved a perfect score, 15 points, as all 5 men finished within 4 seconds (for 10,000 meters). This is a feat that will never be repeated.

When you look at Joe's record, you realize that he has the unique ability to work with elite athletes as well as young men coming out of high school with very average ability. Pat Porter is one example of the latter case. After running 4.23 for the mile and 9.53 for the 2 mile in high school, he came to Dr. Vigil at Adams State and proceeded to win 10 consecutive – 2 collegiate and 8 TAC/USA – National Cross Country titles.

Joe Vigil is a man for the ages. He is the "Picasso" of the track and cross country world. Better yet, his is the "Sylvester Stallone" of the coaching profession. I can say this because I have seen the man in action. People continually come to him for input, advice, favors, lessons in philosophy, autographs - you name it. The man does not have a moment of peace when he is out in public. And yet, I have never seen him turn anyone down. He has time and energy for all, and no question is too minor. He is willing to share his success with any who ask. I divide people into two groups - givers and takers. Dr. Joe Vigil is truly a giver, in every sense of the word. He loves to help people. That's why he has written this book.

There is no secret to Joe Vigil's success. Just be around him for a short time, and you become impressed by the fact that he loves his job. He has a burning passion for excellence, and he has a work ethic second to none. Up at 4:00 a.m. every morning, he begins each day with a roar. I once heard a man say "Great men are working while other men sleep." This man *must* have known Coach Joe.

Each workout designed for Joe's athletes has a very specific scientific reason. Joe Vigil is one of the most intelligent coaches in the world, as attested to by his educational background and his PhD in Exercise Physiology. But even more important is his unique ability to take scientific knowledge and apply it in simple terms so that all can understand and profit by it. This is one of the strong points of ***Road To The Top*** – you can read it, you can understand it and you can apply it.

But there has to be more than just having scientific knowledge and a work ethic for a coach to become truly great. The final ingredient in the mix is what I call "charisma." This is the ability to get your athletes first to listen, and then to do the work, both in practice and in meets. It's the amazing ability to get athletes to believe in themselves. Coach Joe Vigil radiates "charisma." When he enters a room, all eyes turn to him. When he talks, people listen. He is a master at handling and inspiring athletes. He's the kind of man athletes want to win for. He makes each athlete better than they thought they could be.

Road To The Top is not just a book on workouts. It is a book that teaches how to become a total coach. It's about a system; a system that allows each individual to become as great a coach as they want to be.

Joe is a master teacher. He is selling you on the idea that if you believe in yourself, and have the courage, determination, dedication, competitive drive, willingness to sacrifice the little things in life and pay the price for the things that are worthwhile, you can get to *the top of the mountain.*

In Seoul, South Korea, as part of my duties as Assistant Manager of the U.S. Men's Track Team, I attended many meetings that Dr. Joe had with our elite distance runners . . .men like Steve Scott, Johnny Gray, Pat Porter, Bruce Bickford and Sydney Maree. In addition, I have sat in on several team meetings of the Adams State cross country team on the day before National Championships. As I listened to Joe, I came to the realization that here was one of the great leaders of our time. He taught that the difference between a successful athlete and others is found in the strength of will. He taught that each athlete must have a *flaming desire* to win . . . better yet, the will to excel. He taught me that it is essential to understand that races are basically won *first in the hearts* of young athletes, then on the track. Once you have won their hearts, they respond in a most remarkable way – they will follow you anywhere. Dr. Joe Vigil is a "Pied Piper" and his athletes will follow him anywhere.

And finally, in trying to pin down the essence of the man, let me say that Dr. Joe Vigil is the consummate coach, teacher, father, husband and friend. As far as his runners were concerned, he was always interested in the total person. I know for a fact he wanted his athletes to be total citizens, not only good runners and winners, but the type of people Alamosa would be proud of.

Read the book, ***Road To The Top***. Commit it to memory. It's all there if you look for it. As I read it, I could hear Dr. Joe's voice in every paragraph. This book is a monument to the coaching of distance runners. Every coach should have it. This book will make coaches *better coaches,* and runners *better runners.*

July, 1995
Joseph Newton
Head Track and Cross Country Coach
York Community High School
Elmhurst, Illinois USA

Table of Contents

		Page
	Introduction	*ix*
1.	Philosophy	1
2.	The Physiology of Running	9
3.	Periodization of Training	35
4.	Concepts Necessary for Success	53
5.	800/1,500 Meter Training	63
6.	3,000 Steeplechase, 3,000 & 5,000 Meter Training	93
7.	10,000 Meter Training	117
8.	The Marathon	135
9.	Exotic Environments	159
10.	Ancillary Training	197
11.	Team Dynamics	235
	Sources Consulted	250
	Index	251

About the Author

Coach Joe I. Vigil, Ph.D.
(pronounced Vee-hill)

Coach Joe I. Vigil has become a legendary figure in National and International coaching circles. His collegiate teams have won an unprecedented 19 national championships (14 cross country, 2 indoor track and field, and 3 junior TAC cross country). His career has led to 14 international assignments: The Olympic Games, The World Championships, The Pan American Games, The World University Games and seven times head coach for The Cross Country World Championships. In 1997, he was designated as a Master Coach by USATF Coaching Education.

Considered as one of the top clinicians in the western hemisphere, Dr. Vigil's areas of expertise include middle and distance training, altitude physiology, the scientific principles of training and training methodology. His presentations have been enthusiastically received by coaches on 5 continents.

Coach Vigil and his teams have been honored Nationally and Internationally by state legislatures, boards of trustees and various sports organizations. He, personally, has been inducted into four Sports Halls of Fame. His coaching record and educational excellence are testaments to his professional commitment.

Introduction

When we review the results of the last eight Olympic Games or the IAAF World Championships which have been contested every other year since 1983, we can clearly see the American dominance in the medal count. The dominance that we enjoy is in the explosive events, sprints, hurdles, relays, throws and jumps. There is, however, a scarcity of medals in the middle and distance events, 800, 1,500, 3,000 meter steeplechase, 5,000, 10,000, marathon and the walks. American athletes have not shown much success in international competition in these longer distance events.

There are probably many reasons for this demise. The emergence of the East African, Moroccan, Algerian and Mexican runners has cast an intimidation factor for American middle and distance athletes. There are many groups of people involved in the sport who are aware of the problem. They have suggested life-style, lack of media attention, the great number of alternatives for American youth, lack of organization of a national program for emerging athletes, or simply a coaching system that does not provide for a transition to the medal level of performance as causes for this problem. Other common issues intertwined in the problem include the desire for quick results rather than steady training for a planned result, deep changes in family life, a change in the culture and mores in our society, and a seeming undisciplined nature of our societal make up that characterize the American athlete.

I have written ***Road to the Top*** to help address some, if not most of the reasons presented. I believe that with the pool of talent we have in America, there are many individuals who can experience great success at the level in which we are experiencing a famine. If this book is read, understood and its principles properly applied, success in middle and distance running will be forthcoming.

There are five major focal points in this book. The first focus – Chapters 1, 4 and 11 – deal with philosophy of life, necessary concepts and team dynamics. These chapters can help mold the values, the direction and the focus necessary to produce successful athletes. Without the direction of these three chapters, athletes will lack the spirit, the will and the heart to forge ahead.

The second focus – Chapters 2 and 3, includes the physiology of running and periodization. It is important for both coach and athlete to discover and understand the adaptive changes that come about as one begins to train at more intense levels. They must both understand the energy systems which are challenged in the different workouts. They must be aware of and understand the metabolic reactions that occur intercellularly and are affected by long periods of training. Periodization is clearly one of the most difficult concepts to understand and implement. It is a must for the athlete to be at his/her physical and psychological best at the time when it counts, the key event(s) of the year. Coach and athlete must be aware of what is to be accomplished during the Base, Precompetitive, Competitive and Transition periods of training. They must have a firm grasp on the interrelationships between volume and intensity in the different training periods. Lastly, they must know how to implement workouts so that the athlete does not peak too early or too late. It might be necessary to constantly refer to these two chapters until they are fully understood.

The third focus of the book – Chapters 5, 6, 7 and 8 – address the individual events and the training necessary. Events have been grouped together that have common characteristics. Volume, Intensity and Reference Point training for events are introduced and workouts presented. In the final analysis, you must remember that a coach and athlete must be creative enough to design their own workouts, event by event. This text merely provides logical guidelines.

The fourth focus – Chapter 9 – is on exotic environments. The information presented is a must in any book on distance training. Recently the time schedule during the world championships, and before that in the last two Olympic Games, were contested during the heat of the day. The organizing committees catered to the needs of the television people and not to the athletes – a travesty indeed! The knowledge from this chapter might prove to be the edge necessary to eke out a victory in any competitive situation. The benefits an athlete can gain through altitude training is not yet totally accepted by everyone. Until it is, those who train and live at altitude will continue to dominate over those who don't.

Heat and humidity are perhaps the biggest organismic stressors an athlete can encounter. Unless an understanding of how to adapt to these stresses, and what precautions to take, you will never compete successfully in this environment. The reduction in strength and the inability to exert muscular tension experienced under these conditions is hard to calculate. The most important thing is that an athlete learn to hydrate properly and adapt to heat and humidity to eliminate the dangers of heat exhaustion and heat stroke.

Training in cold weather does not present as many problems, but an athlete must understand the reduction in performance levels. Under these conditions, learning what to wear to eliminate the many consequences induced by dangerous wind chill factors and what indexes are safe to train at is imperative.

The fifth focus – Chapter 10 on Ancillary Training – will explores standards in strength, flexibility and power which are necessary to be successful competitors. People involved in the sport must understand that the higher the levels of strength qualities achieved as an athlete, the higher the performance levels in distance running. Most distance runners have alarmingly low strength and flexibility, so care must be taken to implement programs progressively.

I am sure that as you go through the pages of this text you will realize that the science and art of coaching are integral necessities. The athlete must understand what is being presented and what is necessary because then, and only then, will his creative imagination of what is possible become a reality.

GO FOR IT ! !

Joe I. Vigil

Martin Johns, from Taupo, New Zealand, anchors the 4x800 relay (2 mile) at the Penn relays in Philadelphia. Johns won multiple middle distance races before graduating at Adams State.

1 Philosophy

"Every Man Must Find His Own Philosophy ...
... His Attitude Towards Life"

- Lin Yutana

Overview

To achieve our full potential, developing personal values is imperative. Once established, these values assist in defining short and long-term goals. It doesn't matter what the goals are. The intent is to develop a sense of purpose.

Introduction

In his book *Beyond Winning,* Gary Walton captures the basic philosophies of six of the great coaches of our time. Philosophy for life and philosophy for athletics are one and the same. Vince Lombardi, Woody Hayes, John Wooden, James "Doc" Counsilman, Brutus Hamilton, Percy Ceruty and others believed and practiced this philosophy. Those who develop a philosophy will go through life along a straighter road and eventually reach their goals much more quickly and easily than those who have no philosophy at all. It is essential that those who have a dream or vision of accomplishing a goal or a task in life develop a set of guidelines or values which will eventually become their philosophy – their road map to a destination of victory and success.

As goals in life are reached, philosophies can be altered or changed, but the values that guide you are established in your conscious or subconscious behavior and remain, no matter what the goal.

Philosophy and Values

In establishing a philosophy for becoming the best person or athlete that you can be, you must be willing to inquire and understand the most comprehensive principles of reality that are available to you. It is this love of knowledge about your sport and the search for it that directs the course of action which becomes your philosophy, like a huge umbrella hovering over you and constantly reminding you of

what your purpose in life and sport is all about. The values you establish to carry out your philosophy, beliefs, standards of action, moral precept – those things regarded as desirable and worthy characteristics to help achieve your goals – are like guide wires that support the structure and shape of an umbrella. As athletes who are just starting in a sport, a small umbrella with few guide wires is all that is needed. As passion for the sport continues to grow, a stronger and bigger umbrella, with many guide wires, is necessary to support it. With that passion, a world class athlete will develop a complex philosophy having many values to help him/her along the journey to success.

Creativity

It doesn't matter what your goal in life is, you must develop a sense of purpose. To participate in sport, to study, and to train is to believe in something. It is this relentless quest for excellence and the unyielding belief in yourself that challenges you to strive and to overcome. During the process, the individual becomes transformed and inspired to new heights of achievement. You must develop a deep vision and total commitment because then, and only then, will you develop a deeper perspective of life in general.

Choose a goal and work toward it. Later, it can be modified, changed, or abandoned for a better one; but make a decision, decide to decide, plan to plan. If you don't have goals in life or athletics, you may find yourself frustrated and eventually emotionally distraught.

I find people who excel in their endeavors invariably are the ones who, early on, had determination and clear-cut goals and habitually directed all their energies toward fulfilling them.

The decision to go after a goal is the key to success. The determination to stay with it is what brings out the quality of excellence.

Athletics: A Function of Education

While coaching at Adams State College, my combined programs of cross country and track and field were labeled as one of the most successful in the United States. There are probably many reasons for this acclaim, but one stands out more than any other: the athletes believed in the philosophy that athletics is a true function of education. Those who learned to believe in this educational doctrine

achieved high degrees of success. As you go through school – whether it be grades 9–12, your college, technical or vocational education – you must remember that your main purpose in attending any of these institutions is to do the best possible academic work you can because this is your preparation for a lifetime profession. This becomes the basis of a livelihood for the future. Like athletics, if your preparation is poor, your chances of succeeding in this compellingly competitive world will be poor.

The habits you learn of maximizing your intrinsic effort on the practice field must be practiced in the classroom as well. The carry over is simple. If you or someone else reminds you of the purpose and you practice it throughout life, it will eventually become a habit.

Qualities of the Mind

All athletes must pay close attention to the qualities of mind needed for athletic success. Most athletes are ready to make an effort in a race. Few are ready to carry their efforts through months or years of training and racing. The same is observed in classroom activities. One quickly realizes that these are not overnight sports or activities. The enthusiasm on which such persistence is built, "the impassioned will," is possessed by very few athletes. It is necessary, and it can be found but never imposed. Like the great runners Nurmi, Zatopek, Ryun, Viren, Morcelli, Aouita and Ondeiki, each developed a degree of focus and enjoyment which was allied to a clear-sighted sense of purpose that created and revealed the outstanding athletes they were and are. These qualities became inherent in our program at Adams State College, where we enjoyed a 94 percent graduation rate, the highest grade point average in the athletic department, and accompanying successes on the athletic field.

The fundamental condition of the body cannot change overnight, but it can be changed over a period of months and years of training by intelligent and planned employment of all that is locked up in your personality.

The athlete must understand that there can be no hurry. The fundamental condition of the body cannot change overnight, but it can be changed over a period of months and years of training by intelligent and planned employment of all that is

locked up in your personality. A sensible periodization of training must take place. The athlete must listen, learn, persevere and perform. You must not turn back once you have started out. *Decision* is the best description of this positive action, and it is not an easy thing to come by. *Perseverance* has to be part of the mind and character of the athlete.

Once the decision to undertake the lifestyle necessary to become successful in athletics has been made, you must make the commitment to overcome all the pitfalls which will clutter your path and continue to march on. Remember that indecision to direct your life along a positive course is probably the greatest thief of opportunity you can encounter. A life of adventure and self-fulfillment is filled with many decisions, good ones and bad ones, but never give up the spirit to succeed. You have to teach yourself not to worry about the mistakes you make, but to develop the courage to hang in there five minutes longer.

Qualities Athletes Must Possess

If you decide there is to be no turning back, you will have to be ready for many difficult experiences because training and competing are difficult and time consuming. Prepare yourself psychologically to train over the long haul – weeks, months, and possibly years. Many times injuries will delay your progress; remember it does not stop it. Illness may prevent or slow down training. Training can be resumed under these conditions. Athletes can't give up; they work harder and dig deeper.

One thing all athletes must remember is that when training is delayed or stopped, do not resume your training at the level you were, but start up slowly and progress gradually until you reach your original level. Remember that the farther along the road you get, the more confident you become and, therefore, the more able you are to go on. For most athletes, there is one step back for every two steps forward. But this need not be so because the firmness of the forward movement will restrict the backward one.

At Adams State, at the start of their freshman year or the beginning of a new season, our athletes would do one thing. They would take a long and thorough look at what they wished to achieve, how they thought it could be achieved and how long it would take them. The time that we spent in individual and team meetings, surveying our ambitions, was time well spent. You must understand and study carefully the factors involved in long term preparation.

Intelligent forethought is the foundation for success, and positive pride its creator. Thought will map out a route and pride will ensure progress along the way. Intelligence, seeking and using knowledge, is a necessary quality that you must possess.

The more you know about training and competition, the better you will be as a competitor. The more self-respect you have, the more you will stay on the route you have worked out. It helps in all states of your training to have someone to persuade and support you, but, in the end, you will train and race successfully because you want to, not because somebody else wants you to.

The strength of mind and character is perhaps best seen in those men and women who do essentially solitary deeds, or who carry out solitary responsibilities. The genuine athlete must have a strong spirit, vigorous and sane, not easily demoralized or defeated. This resolute balance, allied to intelligence, is the mixture necessary for success.

Characteristics Athletes Must Possess

The culturation of this willpower, this spirit to succeed, is possible. It is capable of tremendous development under the proper training and stimulus, or of near extinction under neglect. This development may not be purely mental because it is possible to train the nervous system, to nurture the body's reserves, and to increase the body's durability. It is also possible to deplete nervous energy and produce a malnutrition of spirit as well as malnutrition of the body.

Losing the desire to achieve excellence and an unintelligent overexertion of the will can break down the psyche, and, in turn, demoralize the athlete. He then tends to defeat himself. It is necessary to accept the very severe limitations under which the human organism must work, including the need for sleep, rest and proper diet, the capacity to function only within a narrow range of temperature, and sensitivity to any heavy and repeated loads of chemical fatigue.

You, the athlete, must disregard slight signs of discomfort and learn to judge when you have started to breakdown rather than to build yourself up. The history of sport is littered with the bodies of people who believed that all they had to do was exert an even will in order to succeed. Their success finally was not much greater than that of those who lacked the necessary will. Their disappointments and frustrations were greater.

Nature cannot be hurried. There are no crash programs in the preparation of an athlete, although the iron-willed athletes who lack intelligence think there are. Men like Ryun, Viren, Moses, Coe, Ovette, and others of their kind, believed and lived by the notion that years of training were necessary for athletic greatness to emerge. Cultivate your physical resources. Don't try to thrash them into life or you may end up destroying them.

Pride, an integral part of the athlete's character, operates to make you want to carry through whatever plans have been conceived. It also operates to make you want to beat other athletes.

This is what sports are all about. There is satisfaction in beating a stopwatch. There is more satisfaction in beating other runners. While this kind of pride should not become an arrogance that sees defeated opponents as necessarily inferior people, it will be a pride which, though unobtrusive, remains stubborn and evident to its owner. Such lack of modesty will belong to the athlete's nature. It need only function in training and competition, and, even there, silently. The noisy athlete does well to remember that most of the world is not listening, and that the interested public applauds the arrogant competitor who leaves his arrogance behind when he steps off the track.

The Place of Athletics in Your Total Life

Finally, you are advised to keep athletics in its place. Be passionately involved in the activity and exert yourself to succeed. Gain from competing, the massive satisfaction that competing offers. Be a well-rounded, sensitive, literate human being. It is not the job of athletics to produce people who know or care for nothing except for athletics. Keep it in its place, behind your family, your concern for the general welfare of the world, and your education. There are athletes and coaches who prepare to act as if athletics were life; it is not. It is but a corner, and a rich one, of life which will contribute immensely to your holistic development.

Coach Vigil on Attitude:

"Your success depends on your mental level of aspiration. If your standards are not high, you'll wallow in mediocrity."

Study Guide

1. Why Develop a Philosophy?

2. Athletics are a _____ of education.

3. What are the qualities of mind?

4. What is the importance of patience?

5. What are the characteristics athletes must possess to be successful?

6. What is the difference between "pride" and "arrogance"?

7. What is the place of athletics in relation to all of life's activities?

Repetition is the mother of learning. A continuous mental and physical review of the tenants presented in this chapter on Philosophy is necessary for them to become part of the moral fabric of the individual.

2 The Physiology of Running

"The only thing that is good is that which comes from the mind."

-Joseph Wadsworth

OVERVIEW

Because of the lack of scientific academic preparation, many coaches are inexperienced in the background of physiology and need to be licensed or certified. This led me and several colleagues to develop Level I and II programs in Coaching Education for TAC/USA (USATF). Within these educational components, we concentrated largely on the physiology of running.

INTRODUCTION

In 1980 I was awarded a sabbatical leave from my duties at Adams State College. My research topic was to study the licentiate procedures for athletic (track and field) coaching. During this period of time I visited the IAAF (International Amateur Athletic Federation) offices of 17 different European, North American, Central American and Micronesian countries. My visitations revealed the academic and/or experience background necessary to be a licensed coach in these countries. After learning what was required by most countries, it became immediately apparent that the preparation of American track and field coaches was academically lacking.

At the time, three other professionals were interested in the same concern: Al Beata, American River College in Sacramento, California; Vern Gambetta, editor of Track Technique; and Gary Winckler, Florida State University. The four of us, together with 30 invited coaches from coast to coast, met in Long Beach, California. It was at this retreat that we came up with the guidelines and curricular materials for the Level I and II programs of coaching education for TAC/USA. In these programs, 50% of the time was dedicated to the science related areas of physiology, biomechanics, psychology and training theory. The other 50% of the time was dedicated to the event specific areas of endurance events, sprints, hurdles and relays, and the throws and jumps.

During the time I served as Coaching Education's National Director, I became involved with some 11,000 coaches. From this association, the weak preparation by coaches became even more apparent. The weaknesses were more obvious in the sciences where most coaches had never had even a single life science course.

From such a large sampling I have concluded that the largest coaching gaps exist in the area of physiology. In order for coaches to prepare training programs for beginning, intermediate, or elite athletes, in middle distance and distance running events, a thorough understanding of the following variables is necessary:

- Training loads
- Energy systems
- VO_2 max
- Anaerobic threshold
- Running economy
- Ratio of fast to slow twitch fibers

Before beginning discussion of these variables, I feel it is important for coaches and athletes to understand the biologic law of training and the overcompensation cycle of training.

The Biologic Law of Training

The basic tenant of training is that in order to increase the size, strength or endurance of muscles, or the functional capacity of other physiological systems, they must be stressed (in both intensity and duration) at levels greater than those normally encountered. This concept is referred to as the Overload Principle. Adaptations to new workloads take a relatively long time, during which further increases may actually have negative effects (overtraining). Coach and athlete must establish guidelines in the preparation of specific micro-mesocycles and label them as preparation, maintenance or development phases of the program.

Dr. Jack Daniels and Dr. Peter Van Handel pointed out that:

✔ Athletes should be allowed to complete a workout feeling better than before. It is not always necessary to increase volume or intensity.

✔ Although the specificity of training is critical, there is a transfer of gains made from other training modes (ancillary training).

When training is developmental, increases in volume and intensity are designed to induce large structural and functional changes in the system. Reducing the training load maintains the functions developed. As I have designed the Biologic Law of Training, please notice how closely allied it is with the tenants of the Overload Principle (Fig. 2.1). The stimulus is the work variable imposed on the athlete. The cell, organ or system immediately goes into a state of fatigue when exposed to this work variable. The response of the body is to compensate metabolically. This compensation goes beyond the normal biological state, as indicated. The result from this adaptation is that the body learns to operate at a higher physiologic level.

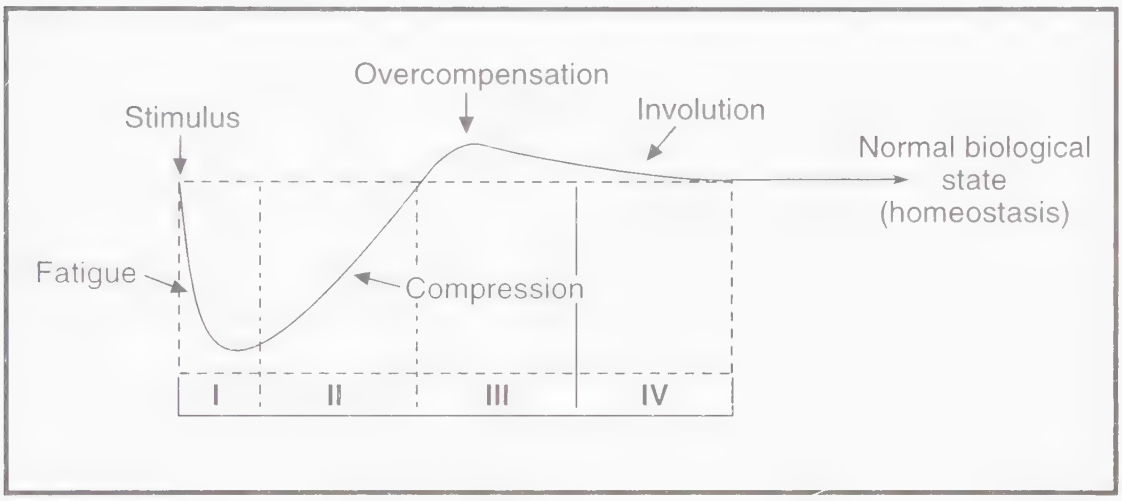

FIGURE 2.1 The overcompensation cycle of a training session. (modified from Yakovlev, 1967)

The Biologic Law of Training

The Structure and Performance capability of an organic system is determined:

I. By its genetic constitution.

- and -

II. The quality and quantity of the work carried out.

The greater the demand/stress placed upon its physiological limits, the more intensely it adapts, and the more efficient it becomes.

I. Training Loads

How athletes adapt to training and handle their training in regard to their total 24 hour day is one of the most important things that coaches and athletes must understand. The training of the neuromuscular stimuli, when applied to, generate a particular future adaptation, is known as the Training Load. There are both internal and external loads, and coaches and athletes must be able to distinguish between them (refer to Table 2.1).

The **External Load** is the actual physical demand placed on the body.

A. The weight lifted
B. The resistance of air to horizontal movement
C. The action of gravity on displacement of mass
    - Quantified as kilograms lifted
    - Vertical feet moved or velocity (speed) as meters/ second, miles/ hour, etc.
D. Duration of activity in minutes or hours
E. Number of repetitions
F. Intensity of repetitions
G. Environmental Factors (psychosocial)
    - *sleep*
    - *work*
    - *heredity*
    - *injury*
    - *school*
    - *social life*
    - *travel and competition*
    - *home environment*
    - *nutrition - diet*
    - *financial status*
    - *training*
    - *coach - athlete interaction*

Internal Load refers to the physiological or biochemical results of the external loading. The following items are influenced by the external loading:

A. Hormone levels
B. Temperature increases or decreases
C. Activation of metabolic pathways
D. Accumulation of waste products in blood, muscles and urine

When these items are measured, physiologists or sports scientists can evaluate the effectiveness of external loading. If optimal adaptations are to be made and overtraining syndromes are to be eliminated, coaches and athletes must be aware of the internal loading.

Although there might be an absence of external loading, internal loading and supracompensatory recovery processes might be in progress as a result of the athletes living environment.

The application of the external load and recovery is considered as a single process and constitutes a training unit. These two processes are inseparable. External loading is the stimulus which reduces functional ability. This response then initiates the mechanism which results in supracompensatory adaptations which eventually lead to improved performances (refer to Figure 2.1).

The observation of internal markers of loading during training, competitions, and recovery helps quantify the immediate external load and sets intensity and duration of training stresses.

TRAINING LOADS

EXTERNAL LOAD

Weight lifted
Air resistance
Gravity Duration of activity
Number of repetitions
Intensity
Environmental factors (psychosocial)

- sleep	- travel & competition	- work
- training	- home environment	- heredity
- injury	- nutrition - diet	- school
- social life	- coach/athlete interaction	- financial status

INTERNAL LOAD

Temperature increases or decreases
Hormone levels
Activation of metabolic pathways
Accumulation of waste products in blood, muscle and urine

Be able to interpret the interaction of the external load on the factors of the internal load and their affect on the athlete.

- The subjective feeling of well-being
- Interpretations of the symptoms of fatigue

TABLE 2.1 The factors that influence the external and internal training loads.

In training there is always a fine line between the stresses an athlete is capable of handling. When reviewing the training histories of athletes, it is clear that overtraining is a problem. In each case athletes will have to reduce or stop training because of injuries or overstress syndrome. This is all because coaches and athletes fail to recognize that maximum loading should approach the capacity of the system, but should not exceed the limits for positive adaptation. Other psychosocial stresses also contribute to the internal loading and are referred to in Table 2.1.

II. Energy Systems

To create movement, muscle cells produce muscular contractions by converting chemical energy into mechanical energy. This is accomplished by production of the molecule adenosine triphosphate (ATP). This molecule can be produced in the muscle cells by using three types of components:

1. Creatine Phosphate
2. Carbohydrates
3. Fats

The most important compound for endurance is the carbohydrate molecules which break down in two ways – *aerobically* in the presence of oxygen, and *anaerobically*, in the absence of oxygen where the end product is lactic acid.

The interaction of the* aerobic *and* anaerobic *energy systems of the muscles is extremely complex. They are linked and actually represent a continuum.

It is an understatement to say that the interaction of these systems during muscular work is extremely complex and represent a continuing area of sports science research. The basic fact remains that the energy systems of the muscles are linked and actually represent a continuum. A discussion of these energy systems – Phosphogens, The Anaerobic (lactic acid) System, and The Aerobic System follows.

A. Phosphogens

The phosphogens include ATP and creatine phosphate and are the immediate and ultimate source of energy for all cellular events, including muscle contraction and relaxation. The following are concluding points that characterize the phosphogens.

1. The breakdown of the phosphogens for muscle contractions begins within a fraction of a second after a neural impulse arrives at the muscle fiber.
2. The supply is limited and this energy source is depleted in about 20–30 seconds.
3. Aerobic and anaerobic processes continually resupply this limited storehouse. This can occur during either recovery or activity.
4. Phosphogen breakdown (oxidation) is the source of immediate energy for short term, high intensity tasks, like short sprints. This source of energy can be replaced during recovery via the aerobic processes.
5. Highly intense intervals, sprint starts, and extremely rapid executed drills are excellent stimuli for this energy system.
6. Intervals should be 10–15 seconds long with rests of 3–6 times the work effort. This high intensity effort activates the system, often depleting it. At the same time, the long recoveries allow the aerobic system to resynthesize the stores.
7. These bouts of exercise must be short enough to minimize lactic acid production.
8. The workout causes a supercompensatory increase in phosphogens (Fig. 2.1), which gets the system to respond faster when called upon.

B. The Anaerobic (Lactic Acid) System

This system allows for the breakdown of carbohydrates which will provide the substrates for aerobic reactions. This allows for rearrangement reactions for the resynthesis of more phosphogens. At a given work intensity the breakdown of the carbohydrate molecules occurs faster than the rate at which intermediate products can be handled by continued aerobic reactions. In order for this system to continue, additional energy is needed, and the intermediates are converted to lactic acid. The work level associated with this phenomenon has been described as the anaerobic threshold.

The anaerobic system accounts for a significant proportion of the energy generated in "all-out" efforts of approximately 1–10 minutes duration. There are shorter intervals (less than 60 seconds) that are conducted at intensities greater than those required to induce maximal aerobic utilization (VO_2 max). The timing is such that the lactate acid system may not be activated quickly enough. The duration of effort is such that large amounts of lactic acid will not accumulate. As with the phosphogens, I have listed some concluding statements that I feel will help you understand the system.

1. The event is over before a large amount of lactic acid can accumulate.
2. Most of the energy for short intense tasks comes from the breakdown of phosphogens in the muscles.
3. Stores are replenished in recovery by aerobic reactions.
4. Even if some lactic acid does accumulate in these extremely short events, it does not have to be tolerated very long.
5. Events longer than 10 minutes must be conducted at less than maximum intensities.
6. Pacing tactics, and a final sprint capability, become important considerations, as does the actual percentage of maximum effort which can be sustained.
7. Anaerobic processes and lactic acid accumulation become progressively less important in longer events.
8. The capacity to produce and tolerate large quantities of lactic acid is essential for success in events which are all-out efforts but are of intermediate duration.
9. Aerobic reactions are functioning at maximal capacity and the anaerobic generation of lactic acid produces the additional energy (phosphogens) needed to continue the task at the selected intensity.
10. An athlete must be able to produce lactic acid in large enough quantities (carbohydrates must be available) as well as tolerate the consequences of its generation and resist its effects.
11. Two basic workouts have been used to train the biochemical pathways involved. The first is to drive the system at high rates by completing

relatively short, but intense, intervals. These may be of 1 to 6 minute duration. Rests vary with intensity and duration of the workout. High intensity is employed to produce large amounts of the waste product *lactic acid*.

12. The second basic workout is longer, but at a less intense level. The basic purpose is to sustain or tolerate the waste product for extended periods – a four, six, eight, or ten mile run of just below anaerobic threshold intensity.

13. Workouts 11 and 12 are also involving the aerobic system at a high level. Both are operating simultaneously. The key is at what percent of maximal aerobic capacity the anaerobic contribution (the anaerobic threshold) is being activated.

C. The Aerobic System

The aerobic breakdown of carbohydrates, fats, and proteins provides substrates for a continuous restoration of the limited phosphogen pool. It is the phosphogen energy which fuels all levels of muscular activity. It is the relative percentage of maximal capacity contributed by the aerobic pathway that varies with intensity and duration of work. At rest, all energy is aerobic because the phosphogens used to write, talk, eat and breathe are continuously replaced by the aerobic metabolism of nutrients. The intensity is very low and the duration can be very long, in fact until the food nutrients are depleted.

Short highly intense efforts quickly deplete the phosphogen stores. Most muscles have enough for about 30 seconds of sustained muscular contractions. These are replaced mostly via the aerobic metabolic pathways. As the duration of effort increases, intensity must decrease and more and more of the energy (phosphogen restoration) must be provided during the task itself. The important concepts that relate to the aerobic system follow:

1. Individuals can sustain all out efforts demanding maximal aerobic capacity for only 8–10 minutes because lactic acid is rapidly accumulating to provide additional energy.

2. Except for short all–out efforts, aerobic processes are continuously providing energy at rates ranging from very low to the individual's maximum.

3. Aerobic energy production occurs whether we are asleep or at maximum exercise capacity. This has led to some confusion on how to train for this system.

4. It is commonly believed that once past the anaerobic threshold, all energy comes from lactic acid production. This is not true.

5. Research shows that the basic external loading factors of frequency and duration or program length is determined by individual fitness levels, and the greatest gains in maximal aerobic capacity occur when exercise intensity is at levels requiring 90–100% of maximal capacity (VO_2 max).

6. The percent improvements or absolute gains are actually lower when training intensities are supramaximal or greater than 100% of VO_2 max. At supramax velocities, the total volume of training is reduced due to the rapid development of fatigue. At the other end of the scale, minimum stimulus required to achieve any improvement appears to be tasks requiring 50% of maximal aerobic capacity.

7. The magnitude of increase in maximal capacity is usually inversely related to initial capacity. Poorly conditioned individuals attain the greatest increases with appropriate training. It is difficult for highly trained athletes to quantify any improvement in VO_2 max. For these individuals, measured values may be limited by heredity rather than by the volume or intensity of training.

8. Greater improvements in highly conditioned athletes can be seen in their anaerobic capacities, economy of effort, and fractionalization (fractional utilization) of maximum capacity during competitive events.

9. When athletes start training, a laboratory or field test to quantify variables other than just VO_2 max should be conducted.

10. The traditional method for improving aerobic capacity has been to form an early season aerobic base by numerous long distance workouts in the weekly schedule (microcycle). These are generally continuous and of moderate intensity and become less frequent and of shorter duration as the annual cycle moves into competitive stages.

A thorough understanding of the following tables is essential and will help the reader understand the energy systems and their relationship to training distances.

Creatine Phosphate	+ ATP	=	Speed
Carbohydrates	+ Lactate	=	Speed Endurance
Carbohydrates	+ O_2 + Lactate	=	Max Aerobic Power
Carbohydrates	+ O_2	=	Anaerobic Threshold
Free Fatty Acids (FFA)	+ O_2	=	Aerobic Threshold

TABLE 2.3 The interrelationship between nutrients and substances and training mode.

Speed	=	100/200 meters
Speed Endurance	=	400/800 meters
Aerobic Power	=	1500/3000/5000 meters
Anaerobic Threshold	=	Pace Endurance
Aerobic Threshold	=	Basic Endurance

TABLE 2.4 The interrelationship between training mode and training distances to be used in a training program.

The Interrelated Variables

Sports scientists around the world have concluded that there are several physiological indicators that determine performance. Although these variables are going to be described individually, it is the interaction of their synergistic effects that determines athletic performance.

Martin and Coe, in their book on training distance runners, stated "maximum performance capacity is based on the sum of the effects of maximum anaerobic metabolism superimposed on aerobic metabolism". In other words, it is extremely important to first develop the highest possible VO_2 max. Keep in mind that continued anaerobic breakdown continues after VO_2 max has been achieved. These additional sources of energy are strictly from anaerobic sources and allow for exercise to be continued some 30–60 seconds after reaching VO_2 max. This effort is a tremendous stress on the physiologic integrity of the body and must be developed progressively to allow the body to adapt to it in stages.

With proper training there is a gradual lowering of the aerobic demand to run at submax pace. This implies better economy of movement. The concept of running economy will be the third variable to be addressed. In order to establish the dynamics of how all these processes take place, a thorough comprehension of the fourth variable of the genetic composition of skeletal muscles is necessary.

It is necessary for coaches and athletes to focus on the training variables discussed to develop them to the fullest within a season, calendar year or quadrennium. The athlete who has learned to improve and allow these variables to interact with one another is the person who will have the greatest potential for winning.

III. VO_2 MAX (MAXIMAL OXYGEN UPTAKE)

Maximal oxygen uptake is a measure of aerobic power. It is highly correlated with endurance events, especially at the highest levels. National and elite class level athletes have VO_2 max values of 65 to 90 ml/kg/min. Women have values slightly lower. (Refer to Table 2.5 for a better understanding of VO_2 max on selected strata of the population.)

Whatever volume of O_2 is brought into the body, the important issue is the maximum amount of O_2 that can be removed from the circulating blood and used by working tissue. This is called oxygen utilization. Table 2.5 shows the VO_2 in ml of VO_2/Kg/min and categorizes the population in 5 different levels. There are two ways to determine VO_2 max, either by a laboratory test or a field test.

	American Population	*European Population*	*Endurance Athletes*
Very Poor	21 ml $\pm$ 2	23 ml $\pm$ 3	50 ml $\pm$ 5
Poor	28 ml $\pm$ 2	30 ml $\pm$ 3	60 ml $\pm$ 5
Average	35 ml $\pm$ 2	37 ml $\pm$ 3	70 ml $\pm$ 5
Excellent	42 ml $\pm$ 2	44 ml $\pm$ 3	80 ml $\pm$ 5
Superior	49 ml $\pm$ 2	51 ml $\pm$ 3	90 ml

TABLE 2.5 VO_2 values on three selected population groups.

Laboratory Determination of VO_2 Max

VO_2 max can be measured in the laboratory through a graded treadmill test to exhaustion. Valid measurements require that the athlete be familiar with the test protocol and be motivated to produce a maximum effort. VO_2 max is considered attained when the heart rate fails to increase with increases in work load.

The four basic variables measured are R=perceived exertion, L=lactate concentration, V=VO_2 max, and H=heart rate. I refer you to the testing profile illustrated in Figure 2.2. The dynamics of this test are as follow:

A. The test starts at a very manageable submax pace, 255 meters per minute or a 6:18 pace after a five minute warm-up. This pace continues for three minutes, at which time measurements on R, L, V, and H are obtained and recorded through metabolic and lactate analysis.

B. As the test continues, all data is recorded in three minute segments, and the progressions of these recordings are displayed.

C. Note the increases of work intensity in minutes per mile, 6:18, 5:51, 5:27, 5:06, 4:48. 4:32. 4:20. and their corresponding speeds in meters/minute.

D. Plotting the increases in variables against the speed run gives an excellent profile on how the athlete adapted to the various speeds.

E. When the maximum work tolerance is reached, the test is stopped.

F. Blood lactate level peaks about five minutes post–test and is recorded as max lactate.

>> See Figure 2.2 <<

1. The established velocity at max VO_2 is a 4:24 mile (vVO_2 max). This pace (or percentage thereof) is an extremely important piece of training information.

2. Aerobic training should be at 55-75% of vVO_2. The above profile reveals speeds of from 5:27-5:06 per mile.

3. Anaerobic threshold training at 4mM is 4:44 per mile.

4. Aerobic capacity training at 100% VO_2 is 4:24 per mile.

5. Aerobic threshold training is a 5:05 mile pace and, in this particular subject, is producing a very low lactate response of 1.8mM.

6. Study all the data obtained from this graded exercise test (GXT) in relation to the speeds run. Observe how the body responds to the variables described.

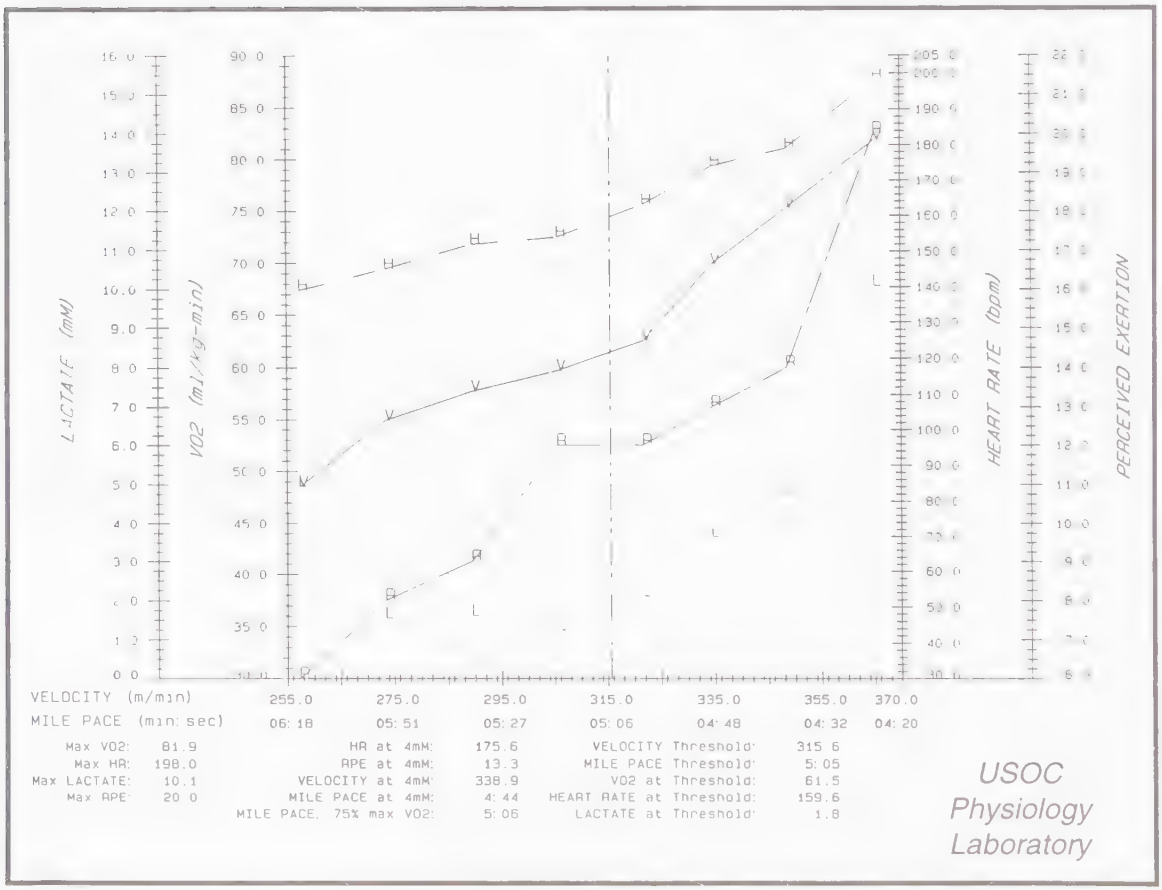

FIGURE 2.2 Physiologic Testing Protocol where heart rate (HR), perceived exertion (R), oxygen uptake VO_2, and lactate (L), are plotted against velocity in run.

Balke's Field Test for Determination of VO_2 max

The purpose of this test is to determine a person's VO_2 max without the use of any sophisticated laboratory equipment. All that is needed is a measured track and a stopwatch.

Steps:

1. Subject runs as far as possible in 15 minutes. The distance is accurately recorded.
2. Distance is converted to meters. There are 1,609 meters in a mile.
3. Total meters are divided by 15 to get meters per minute.
4. The first 150 meters (base) is equivalent to 33.3 ml/kg/min.
5. For every meter over 150 meters, multiply by .178 ml and add to the base of 33.3 ml.
6. For every meter under 150 meters, multiply by .178 ml and subtract from base.

> Example - Subject A covers 4,800 meters in 15 minutes, which is 320 meters/minute. You subtract 320–150= 170. Multiply by .178 (.178 x 170 meters=30.26.) Base 33.3 ml + 30.26 ml = VO_2 of 63.56 ml.

The 4,800 meters is equal to a distance of 2.98 miles and a 5:03 per mile pace. The 5:03 illustrates the subjects velocity at VO_2 max.

It is not only beneficial to know VO_2 max, but the two testing protocols also reveal the velocity at VO_2 max (vVO_2). This information then becomes the basic training tool for the athlete at that fitness level.

The greatest gains in maximal aerobic capacity occur when the exercise intensity is at levels requiring 90–100% of maximal capacity (VO_2 max). Percent improvements or absolute gains are actually lower when training intensities are supra-maximal (or greater than 100% of VO_2 max) because the total volume of training is reduced due to the rapid development of fatigue. The minimum stimulus required to achieve any improvement appears to be tasks requiring above 60% of maximum aerobic capacity (refer to Table 2.6).

IV. Anaerobic Threshold

Before the discussion on anaerobic threshold, several points need to be discussed regarding the aerobic producing mechanism.

1. Individuals who are poorly conditioned attain the greatest increases with appropriate training. Highly conditioned athletes may find it extremely difficult to show improvement.

2. The research points out that, there are many individuals whose measured values may be more limited by heredity than by the volume and intensity of their training.

3. Greater improvements from training can be seen in the individual's anaerobic capacities, economy of effort and fractional utilization of maximal capacity during competition.

4. The traditional method for improving aerobic capacity has been to form an early season base by incorporating several long distance (aerobic workouts) runs during the weekly microcycle. Those runs are of moderate intensity. They generally are run less frequently and are of shorter duration as the season progresses into the competition phases.

	Mile Time Speed							
vVO_2 pace	100%	95%	90%	85%	80%	75%	70%	60%
	4:20	4:33	4:48	5:05	5:25	5:46	6:11	7:13
	4:30	4:44	5:00	5:17	5:37	6:00	6:25	7:30
	4:40	4:56	5:11	5:29	5:50	6:13	6:40	7:46
	4:50	5:05	5:22	5:41	6:02	6:26	6:54	8:03
	5:00	5:15	5:33	5:58	6:15	6:40	7:08	——
	5:10	5:26	5:44	6:04	6:27	6:53	7:22	——
	5:20	5:36	5:55	6:16	6:40	7:06	7:37	——
	5:30	5:47	6:06	6:28	6:52	7:20	7:51	——
	5:40	5:57	6:17	6:40	7:05	7:33	8:05	——
	5:50	6:08	6:28	6:51	7:17	7:46	8:20	——
	6:00	6:18	6:40	7:03	7:30	8:00	——	——

Table 2.6 The mile speed at various percents of VO_2 max. (vVO_2 pace)

Having studied the laboratory analysis in Figure 2.2, one can see how lactic acid production increases as the intensity of effort increases. Therefore, at his/her anaerobic threshold (AT), the athlete is producing more lactic acid than is being eliminated. The quantification of this value is an accumulation of 4mMLa/dL blood. The importance of lactate threshold to the athlete is that its appearance marks significant anaerobic metabolism. Also, this intensity of effort is associated with high oxygen utilization. It has been determined that the AT pace, or intensity of effort, can be anywhere between 60–95% of maximal aerobic capacity (VO_2 max). When training at this pace, athletes stimulate both the aerobic and anaerobic systems of phosphogen restoration which are functioning simultaneously. I would like to stress the importance of the intensity of pace at AT for several reasons.

First, the average velocity that an athlete can sustain for races over approximately 15 minutes duration is fairly close to that which blood lactic acid begins to accumulate rapidly. Disregarding all other factors, the person with the highest average speed of AT wins the race. Success in these events is related to having a high maximal aerobic capacity. It also requires the athlete to hold the race pace (AT) which is at a high percentage of the athletes maximal capacity (VO_2 max).

Exercise physiologists and sports scientists refer to this as having a high functional utilization, meaning the athlete can effectively use a high percentage of maximal abilities for long periods. Athletes and coaches must be strongly advised that just having a high VO_2 max alone and testing only for VO_2 max is not in the best interest of the athlete. The athlete who can sustain a pace requiring 90% of a max of 75mL oxygen (68mL) is considerably better off than one who has a maximal aerobic capacity of 80mL oxygen but can only sustain a pace requiring 70% (56mL) of that max. This one point illustrates the importance of monitoring max and submax abilities.

Secondly, evidence shows that training at the AT intensity pace is the most effective way of inducing shifts in the lactic acid vs. velocity profile. In short, the AT now occurs at a faster speed and higher percentage of maximal aerobic capacity. If this pace or intensity is already at high levels (90-95% VO_2 max) then it would be the most effective pace for increasing VO_2 max.

Athletes who train too far below the AT pace do not stimulate the anaerobic processes for lactate production and removal within the muscle. It would be like running another aerobic pace workout. On the other hand, a pace which is run too fast induces rapid production and accumulation of the waste product (lactate). This

condition brings on early fatigue with less work being accomplished than is necessary for improvement.

While studying the lactate threshold points in Figure 2.2, observe that the heart rate at 4mM is 175bpm, which is approximately 88% of subject's max heart rate. In our program at Adams State College, when we had no laboratory determined value, we recommended an AT run with the pace that would produce a heart rate of between 168-172 bpm. Upon further investigation of this subject's data, we could ascertain that his fractional utilization (% of VO_2 max) – the VO_2 max at which anaerobic threshold of 4mM was reached – was 85-87% of VO_2 max. His mile pace in running an AT run was 4:53/mile, or 19:32 for a 4 mile AT run, which this particular individual could run once a week when there was no scheduled meet.

Once the appropriate AT pace has been identified, training protocols to increase both the AT point and the fractional utilization must be developed. The methods that have been used at Adams State for collegiate, post-collegiate, and elite international runners are as follows:

1. A tempo run of 20 minutes or 4 miles, whichever comes first. Our stronger athletes occasionally attempt 6-8-10 mile runs at AT pace.

2. Long interval runs of 2–3 x 5 - 15 minutes (2-4 kilometers) with a 3–5 minute active rest interval.

3. Long interval runs of 2–3 x 16 - 17 minutes (5 kilometers) with rest interval where recovery is near complete.

All three training protocols stress the aerobic system at high levels while the athlete tolerates discomfort associated with accumulation of lactic acid during work. These workouts are more frequently used during competitive microcycles and are followed by aerobic workouts.

V. Running Economy

A. Defined.

In running, economy of motion is determined by measuring the oxygen consumed while covering a given distance. Covering a mile at a walking pace is less energy costly (requires less oxygen) than running a mile at the fastest possible

speed. Competitive runners are interested in running economy because, all other factors being equal, the runner who is the most efficient at race pace will prevail. There are many 5,000 meter runners whose VO_2 max is over 80mL/Kg/min, but they can't run 5,000 meters under 14 minutes. There are also many 800 meter runners who can produce 20mM lactate in short maximal running, but can't run 800 meters under 1:55.

Running economy deals with efforts below the level of maximum oxygen uptake, called VO_2 submax. Maintenance of any submax pace requires a balance between stride length and stride frequency at the minimal oxygen cost.

In physics, efficiency, is the amount of energy consumed divided by work performed. Human running efficiency is difficult to determine, so oxygen cost (energy) is divided by distance covered for a measure of running economy.

Running economy can be measured through gas analysis, heart rate, blood lactate, biomechanical analysis, and other means. Comparisons of individuals is often reduced to who consumed the least amount of oxygen to perform a given amount of work.

Economy of motion involves many factors, some extrinsic (environmental) and some intrinsic (physiological). Extrinsic factors include temperature, wind, grade, surface, shoe sole hardness, shoe weight, and altitude. Intrinsic factors include body weight, genetics, state of fitness, age, fatigue, circadian and circannual rhythms, relaxation and hypnotic suggestion, health and a host of biomechanical measures.

B. The Development of Running Economy

Training is the fundamental factor which improves running economy. High volume training has a positive effect, but only at the speeds practiced. Optimal speed training can improve running economy at fast speeds. Therefore, training at certain paces seems to transfer the best running economy to that speed. The main thrust of coaching is to develop optimal economy at race pace.

We also know that running economy tends to decrease when the runner trains too hard. Heavy training always decreases running economy. However, the possible and casual decrease in hard training is minimal at the main training paces. After training hard, rest always improves running economy at all speeds.

The four factors that contribute to maximal sustainable paces are:

1. The genetic composition of muscle fibers (fast twitch/slow twitch).
2. The gradual lowering of aerobic demand at submaximal pace.
3. The improvement in the oxygen consumption capability of working muscles:
    a. increased capillarization,
    b. increased numbers of mitochondria,
    c. enzyme activity.
4. The gradual improvement in the ability to buffer increasing acidosis and maintain recruitment of fast twitch muscle fibers.

Running training for maximal sustainable pace must include workouts which develop a high VO_2 max, increase the lactate threshold, improve running economy, and increase tolerance of the metabolic acidosis.

C. Economy Factors and Their Training

It has been accepted that long distance running performance is due to three main factors:

Capacity to produce energy:

1. **VO_2 max**
2. **Operate at high La max**
3. **Economy of motion**

Running Performance
Running Economy
Running Speed

All three factors are interrelated and operate with each other. Running economy depends on endurance and running speed. Without endurance, it is impossible to run the 5,000 meters economically. You may be able to run 2,000 meters economically but this is not enough. If you don't have enough speed in the 800 meter run, it is clear that you can't run the first 400 in 52 seconds economically.

Training to conserve and develop running economy	*Economical factors in long distance running*	*Other methods to increase/conserve running economy*
- Balanced and varied endurance training - Strength - Stretching - Technique drills - Relaxation exercises - Short repetitions at under mileage pace	Factors of fitness: - Endurance - Strength and strength endurance Technique: - Coordination - Muscle strength balance - Mobility - Relaxation Speed Resources: - Speed - Under mileage performance	Rest Muscle service - Massage - Physical therapy - Restoring balanced nutrition

In conclusion, it seems that the most effective methods to improve and maintain the running economy are strength and speed training methods. Event specific strength together with speed reserve is the key to running economy.

VI. Muscle Fibers

All skeletal muscle units function in the same general manner. There is a degree of specialization among the units. There are two types of fibers units, the fast twitch (Ft.) and the slow twitch (ST). The functions of these two basic motor units are quite different. This difference is significant with respect to various sports performances.

A systematic and methodologic way of training relates muscle adaptation to exercise. A more careful examination reveals that FT fibers have two important subtypes: FTb and FTa. In normal untrained subjects, FTb fibers generally predominate in the FT pool. With training, an adaptive characteristic is that the FTb are modified to FTa fibers. This means that FTa fibers develop the ability to develop oxidative enzyme activity, much like ST fibers. For a complete understanding of the difference between the three types of fibers, refer to Table 2.7.

The anaerobic capacity of FT fibers is much greater than that of ST fibers. Both units contain enzymes involved in facilitating the reactions of the ATP-PC system. However, the enzymes in the FT fibers are about three times as active as those in ST fibers. An enzyme is more active when it has greater functional capabilities than other enzymes. Both units contain glycolytic enzymes, but the enzymes in FT fibers are up to two times more active than those in ST fibers. FT fibers are biochemically suited for speed or explosive activities.

CHARACTERISTIC	ST	FTa	FTb
Neural Aspects			
Motoneuron size	small	large	large
Motoneuron recruitment threshold	low	high	high
Motor nerve conduction velocity	slow	fast	fast
Structural Aspects			
Muscle fiber diameter	small	large	large
Mitochondria density	high	high	low
Capillary density	high	medium	low
Myoglobin content	high	medium	low
Energy Substrate			
Creatinphosphate stores	low	high	high
Glycogen stores	low	high	high
Triglyceride stores	high	medium	low
Enzymatic Aspects			
Glycolytic enzyme activity	low	high	high
Oxidative enzyme activity	high	high	low
Functional Aspects			
Twitch (contraction) time	slow	fast	fast
Relaxation time	slow	fast	fast
Force production	low	high	high
Fatigue resistance	high	low	low
Distribution			
Endurance athletes	high >60%	med to high ±40%	low ± 10%
Sprint athletes	med to low <40%	med to high ±30%	high ±30%

Table 2.7 Characteristics of fast twitch (FTa and FTb) and slow twitch (ST) motor units (Modified from Fox Bowers and Foss, Sports Physiology)

Conversely, the aerobic capacity of ST fibers is much greater than that of FT fibers. All the enzymes involved in the reactions of the aerobic system have activities in the ST fibers. Additionally, the number and the size of the mitochondria, (where aerobic reactions occur) is much greater in ST fibers. Both the number of capillaries per fiber and the myoglobin content are higher in ST fibers. These are both important for a greater aerobic activity. It can therefore be concluded that the ST fibers are best suited biochemically for endurance type activities. The amount of stored glycogen is about the same in the two fiber types. However, the ST fibers have nearly three times the triglyceride (fat) stores as FT fibers.

Recent evidence has strongly suggested that fiber type distribution in humans is determined solely by heredity. It has also been concluded that the percent distribution of fiber types in humans does not change following endurance, sprint, or weight resistance training. Athletes who are genetically endowed with a preponderance of ST fibers select endurance activities because they are successful in those activities. Those athletes who are genetically endowed with a greater percentage of FT fibers select explosive or speed activities because they are successful in those kinds of activities. Other important characteristics of the different fiber types are as follows:

1. FT fiber generates maximal muscular tension in about one third the time than does ST fibers. FT fibers have greater anaerobic capacities and larger motoneurons which innervate FT fibers.

2. The force of contraction in FT fibers is much greater and is directly related to the size of the individual fibers and to the number of fibers making up the individual motor unit.

3. The recruitment of both FT and ST fibers is called upon during most sports activities. However, ST fibers are used preferentially during performance of endurance activities. FT fibers are used during the performance of sprint-like activities.

4. In order to increase the metabolic potential of FT fibers, training must consist of high intensity exercises. This will ensure that FT fibers will be active during the training sessions.

5. Similarly, to increase the metabolic potential of ST fibers, the training activity must consist of lower intensity, longer duration exercises. Under these conditions. ST fibers will be used preferentially.

6. An analysis of the distribution of fibers in male and female athletes shows that athletes who train for sports that involve short duration, high intensity activities tend to have greater percentages of FT fibers. Refer to Table 2.7.

7. In contrast, endurance athletes tend to have greater percentages of ST fibers. This holds true for both men and women. Refer to Table 2.8.

Activity	% ST Fibers	% FT Fibers
Marathoners	82	18
Distance Runners	68	32
Race Walkers	60	40
Javelin Throwers	50	50
Runners - 800m	46	54
Shot Putters/	44	56
Discus Throwers	37	63
Sprinters/Jumpers	36	64

Table 2.8 Approximate percentage of fiber distribution found in selected track and field activities.

"One of the big observations of human nature is that when people get close to the end, they tend to relax. Get away from the habit of relaxing. Run through the finish line as in a track race. When there is a goal in sight, work hard toward it. You should work harder the last several weeks."

Coach Vigil at team meeting,
3 weeks before Nationals

Study Guide

1. What is the Biologic Law of Training and how does it relate to running improvements?

2. Describe the 4 stages of the overcompensation cycle and how it relates to training.

3. Describe both the external and internal training loads and the interrelationship between them.

4. Understand the basic principles of the three energy systems and what intensity of stimulus is necessary to go from one system to the other. Also, be able to describe how these systems might be used simultaneously.

5. Describe the concept of VO_2 max and how one might improve it. What is the importance of VO_2 max in establishing training programs?

6. What is the anaerobic threshold, how can it be achieved, and how can anaerobic threshold training be incorporated in a running program?

7. What is running economy and how can it be achieved?

8. Understand the two basic types of fibers and how a third type might be developed. How does each fiber type contribute to the development of muscle tension generation?

A functional capacity test typifies what an Adams State College athlete would go through to determine:

1. VO_2 max
2. Aerobic threshold
3. Anaerobic threshold
4. Lactate concentration
5. Heart rate
6. Perceived exertion

The adhesive white discs on the runners help determine the biomechanics in high speed photography in order to determine stride frequency and stride length.

3 Periodization of Training

"Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skillful execution. Quality represents the wise choice of many alternatives."

- Willa A. Foster

Overview

There are three phases in the concept of periodization - the base phase (aerobic phase), the competitive phase (leading to a psychological and physiological best) and the transitional phase (recovery). Periodization has two purposes: a) it allows the athletes to reach their potential; b) if carried through correctly, it guarantees that peak performance of training is achieved at the correct time.

Introduction

My career has brought me various coaching experiences. I have been a national and international track coach, an international track and field clinician who has lectured in five continents, a professor of the Techniques of Coaching Track and Field, and a former national director of the National (USATF) Coaching Education Program. I have had the responsibility of presenting programs in sound methodology of training and coaching. To this end, I have researched the literature, traveled world–wide and visited many of the world's most outstanding coaches and training theorists.

In addition, I have developed a fifty-hour course on the advanced theory and methodology of training. This course is based on an eclectic presentation of cross-referencing of leading training methodologists of the past fifty years. This list includes Tudor Bompa of Toronto, Canada; Frank Dick, director of coaching and national coach for the British Athletic Foundation; Dr. Dietrich Harre from the German Democratic Republic (GDR); L. Matveyev from the former Union of Soviet Socialist Republic (USSR); and Gerhardt Schmolinsky from Leipzig, East Germany.

From these experiences I would like to discuss numerous items I feel are necessary for coaches and athletes to understand. I believe that the more interrelated variables in training theory that the coach and the athlete understand, the greater is their potential to produce a championship athletic performance. I have practiced periodization of training with my teams and individuals for 15 years with great success.

As the proper periodization cycles are employed in the training program, the athlete can see and understand the repetition of the previous cycle and how it applies to the new cycle.

Periodization is an intelligent and organized plan of training over a period of time. It has two purposes: 1) to allow athletes to reach their potential; 2) to guarantee that the peak performance is achieved at the correct time. Experienced athletes who employ periodization and long term training plans benefit more as a result of their greater experience and higher levels of athleticism. Athletes who compete at lower levels can also benefit from this method of training.

As a result of periodization, two objectives can be met:

A) realistic goal setting relative to potential, and

B) reduced potential for injury or overuse syndromes.

Periodization is not only for competitive athletes. Individuals who are interested in training for fitness can also benefit by employing the training factors of intensity, frequency, and duration. If the goal is to participate in an activity beyond the normal routine, planned training is necessary.

One of the most important concepts of periodization is continuity of training. If an athlete is to achieve the elite status, uninterrupted training of different intensities has to be maintained throughout the year. This guarantees that the athlete will achieve the greatest physiological and psychological adaptations necessary to be successful. The flow patterns designed in training and the proper interrelationship between volume and intensity allows athletes to peak at the planned time. As the proper cycles are employed in the training program, one can understand the repetition of the previous cycle and how it applies to the new cycle. Progressive increases can still be employed. It is these progressive qualities in intensity, frequency, and duration that allow cumulative physiological adaptations to occur.

Training Cycles

Microcycle

A microcycle is a short period of training of one week duration. There are coaches who incorporate 10–14 day microcycles. The microcycle can include from one to three training units per day. The total number of training units can vary from one per day, for beginning athletes, to between eighteen and twenty-one units during a seven-day microcycle for elite performers. Figure 3.1 illustrates the variations between workouts during one microcycle. Notice that intensity and duration of the workouts vary. The intervals are generally of high intensity and short duration. Long runs are of lower intensity and are continuous. The training units are illustrated by broken columns for interval type workouts and solid columns for longer runs. While studying Figure 3.1, notice the patterns of alternation between intensity and duration as well as the incorporation of rest intervals (R) in the cycle.

Mesocycle

A mesocycle consists of a training period from four to eight weeks. This time period is necessary for a cumulative adaptation of the physiologic stresses to occur. During this time, specific stimuli can be induced on the athlete which incorporates physiologic, mechanic, or psychological adaptations. These specific stimuli can also bring about improvements in running economy, anaerobic threshold, or max aerobic capacity. Note Figure 3.1 where a typical microcycle is displayed in the upper end and where work intensities and stress flow are altered throughout the week. Also, observe the bottom figure where a typical series of one-week microcycles are illustrated and where the relative intensities each week are displayed. Week five of the mesocycle is the microcycle in the upper portion of Figure 3.1.

Macrocycle

A macrocycle consists of a group of three to four mesocycles which have a specific purpose and form a major long duration cycle. The competition structure of the sport and the adaptability of the athlete determines the length of the cycle and its composition. It may consist of one peaking period, a short semiannual period, or an annual period. A longer macrocycle of two or four years (an Olympic quadrennium) may also be used.

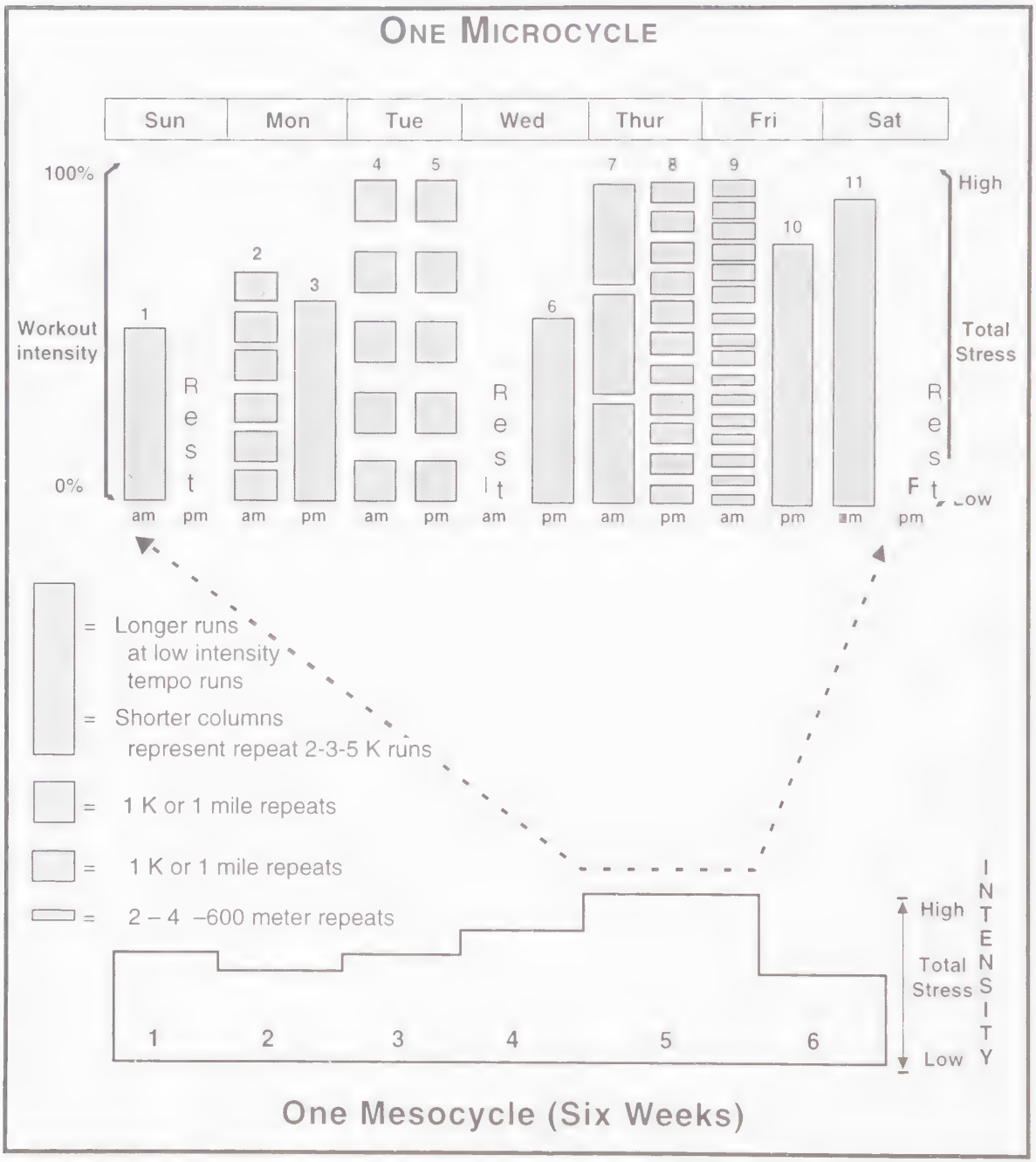

FIGURE 3.1 Example of one microcycle with eleven distinct training units. Note intensity and frequency workloads. The bottom portion illustrates how one microcycle fits into a six-week mesocycle.

The groups in a macrocycle are called phases and are described as:

A. ***Basic or preparation phase***
A period of time in which functional capacity is increased.

B. ***Competition phase***
A period of time where a person maintains a competitive fitness capacity for a period of competitive peaks.

C. ***Transition phase***
A short period of time of active rest which allows a decrease in training stresses to eliminate the possibility of overtraining. This can also serve as a rest period between two successive levels of competitive development.

Note that a phase is longer than a mesocycle, but shorter than a macrocycle.

Training Components

The formation of a long term training program dictates consideration of many specific aspects.

A. The development of training and competition goals.
B. The development of specific training task.
C. The development of the training unit (1, 2, or 3) per day.
D. The development of standard tests to periodically evaluate functional capacity in training or in competition.

When the daily training unit(s) are completed, the athlete will experience both immediate and cumulative adaptive effects.

Goals

The athlete and the coach must establish goals for the competitions to be encountered and the training to be undertaken. Competition can be affected by unexpected factors such as race strategy, injury, environmental conditions, illness, travel, or dietary problems. As a direct result, the competition goals may or may not be met independent of training goals. The athlete and the coach must focus on selected, major events. At the same time minor competitions and "tests" can be considered as part of the training plan and can be used to modify the workout plan. The constant feedback to the athlete and his/her adaptability is of vital importance.

At Adams State we had 16′ X 4′ bulletin board that demonstrated all the periodization periods and different training modes. In addition, it displayed a 52 week time period where we could plug in peaking dates. As athletes had their weekly conference with me in my office, either individually or in groups, we discussed where they were in relation to the key date or event that they wanted to be at their optimal best. If there was a need for modification or adjustment in a workout schedule, one was made. If there was not a visible need for change, we continued on the predetermined path. This weekly dialogue was extremely important and eliminated a lot of physiological and psychological problems. In addition, the athlete was making positive progress toward the goal.

The ***training cycle*** is generally practiced for a 4-6 week mesocycle and is used to work on physiological, mechanical, or psychological weaknesses. The workout goal may be as minimal as the completion of a hard workout for a young athlete or acceptance of a difficult task in the training unit which a more accomplished athlete had previously rejected. In each case these training goals are continually modified as adaptations take place.

The ***tasks,*** the mode of training, depend on the immediate goals for that particular part of the training cycle. These tasks are closely related to the particularity of the event and are commonly referred to as *task-specific*. In this case, tasks performed must be specific to running. The intensity, duration, and frequency will be determined by the athlete's response to standardized laboratory tests, field tests or activities. Other tasks, such as activities during injury or tasks to improve strength or flexibility, can be incorporated in the daily training lesson. Also, activities to provide breaks from the physical and mental stresses of intense specific training can be used.

The Training Unit

Each workout (unit) is a systematically organized set of exercises and recovery bouts based on the athlete's fitness status and response to the new stress. These training tasks define the athlete's maximal capacity and tolerance to the training activities imposed. Each training unit is separated by a longer recovery period of 4–6 hours and can be referred to as *restitution*. The restitution recovery may or may not include overnight rest. It is always longer than recovery intervals between the repetitions or exercises performed in a training unit. The restitution process depends on dietary factors and access to modalities such as therapeutic or rehabilitative massage. It can also depend on age and the fitness status of the athlete. Older, more experienced and stronger athletes may be able to

tolerate two training units per day over a five-day period, but younger, less accomplished athletes may be able to tolerate only one training session per day. Every training unit must include the following items:

1. Warm up/cool down
2. Training tasks (one of the following)
   a. Intense short intervals
   b. Long aerobic run at 80–90–95% of VO_2 max
   c. Anaerobic threshold run between 65–90% of VO_2 max
   d. Recovery run 60% of VO_2 max
   e. Resistance and/or flexibility workout

As these tasks are accomplished, the coach and athlete can observe the cumulative effects on the athlete as he/she goes through the microcycle. At the beginning of the next microcycle, changes can be made that will allow for a smoother adaptation to increases.

The Training Effects

There are always homeostatic imbalances as a result of an athlete finishing a difficult training unit. Those changes can involve physiological, hematological, mechanical, or psychological changes. The effects that training has on an athlete can change from day to day, but generally depend on the current or initial fitness status of the athlete, the absolute ultimate potential of the athlete, the content of the training unit and the restitution recovery time allowed between training units.

Immediate Effects

The immediate effects of a training unit are seen after the workout. The effects on the athlete would be determined by the duration and intensity of the training task and would include the following:

1. Reduced performance capacity
2. Reduced muscle and liver glycogen stores
3. Elevated functional status of the neuromuscular, metabolic, respiration and cardiovascular systems, as indicated by an increased heart rate, oxygen uptake, or internal temperature
4. Increased concentration of metabolic residues such as lactic acid and ammonia
5. Decreases in water, electrolytes and any shifts in the fluid compartments
6. Increases in some endocrinological/hormonal and neurological pathways.

The immediate effects (the results of the training unit) are associated with acute fatigue. It is extremely important that the initiation of the restitution recovery processes take place, such as repayment of oxygen debt, removal of metabolic waste products and the resynthesis of carbohydrates (ATP/PC-glycogen) in the storage depots.

Residual Effects

The effects of the previous training session and the length and type (active or passive) of the recovery period will determine the magnitude of the residual effects. As an example, an athlete can have too little or too much restitution recovery time. This can actually result in overtraining or undertraining without changing the athlete's workloads or tasks. The ultimate goal for the coach and athlete is to manipulate the work/rest factors so that the overall training adaptions do not remain stable but progressively improve function, which ultimately improves athletic performance.

Cumulative Effects

The cumulative effect of training will be noticeable in the increases of function of the stressed organs. See "Biological Law of Training" on page 13. The magnitude of the cumulative effects is determined by the volume of work completed and the duration of the particular training phase.

The noticeable outcomes of using the proper periodization concepts are progressively improved status of training and improved physical condition. With inappropriate assignment of training tasks and recovery intervals we notice over-training or reduced physical status.

Notice should be taken of the immediate, residual and cumulative effects the training lessons and the individual training tasks have on the athlete. Documentation of the effects of each aspect must be evaluated. This practice and observations of the athlete are the secrets to coaching. It is here that the increases in activity and appropriate restitution will have a profound effect on the athlete's ability to maintain enthusiasm for training over the long–haul and years of commitment to the sport.

Tests

The word *tests* does not necessarily mean a time trial or a performance in competition. It can also refer to external indicators of stress, such as increases in

duration and intensity of workouts. If subjective observations are not made by the coach during workouts, proper readjustments will not take place. The training sessions will then be a hit or miss situation determined by chance. In addition, internal markers such as blood lactic acid, heart rate and oxygen uptake can serve to quantify the specific abilities of key stresses necessary to maximally optimize training. If an athlete has a basal heart rate of 44 and the BHR (basal heart rate) goes up more than 10%, it is necessary to take precaution and prolong the restitution for another day or until the BHR comes down to the original base level.

I will describe several different macrocycles to show the methods of identifying the various phases and the flow patterns of training. It is very important to identify and establish the key date or key series of competitions which will occur during the year or season. One can then count back to see how much training time is available to prepare for that key date. Using this system, key dates can be established to guarantee maximum physical and psychological preparedness.

Remember to use the calender year starting with January through December, or a competition calender based on when championships are held. At the elite levels, a competition phase could be stretched to include nearly a whole calender year. Experience has shown that an athlete must never attempt to hold a competitive performance level that long because it would be counterproductive. The least important contests should be considered as preparation for the most important two or three competitions of the year. Figure 3.2 describes a competition calender illustrating the training principles.

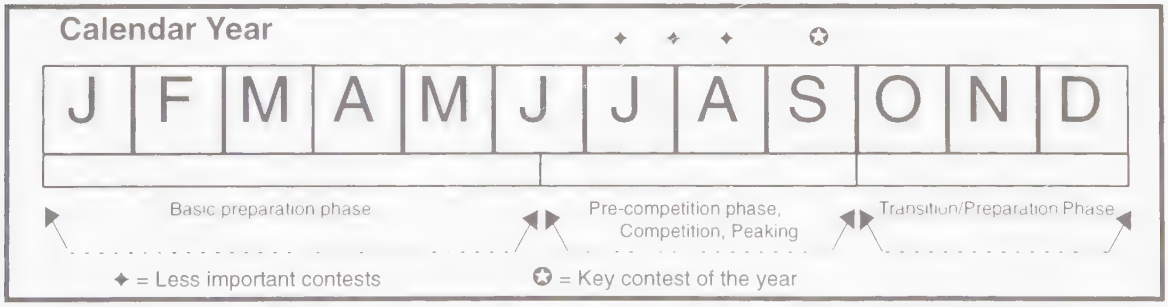
Calendar Year
J F M A M J J A S O N D
Basic preparation phase
Pre-competition phase, Competition, Peaking
Transition/Preparation Phase
✦ = Less important contests
✪ = Key contest of the year

FIGURE 3.2 A monocycle showing the different phases and months, and the competitions leading to the main event of the year.

In studying Figure 3.3, notice that the calender months have been shifted so that the macrocycle begins with the preparation phase (September) and ends with the off-season transition (July through August). The activity during this phase can be called active rest. Participation in the numerous recreational activities which are non–sport specific allows for complete neuromuscular, physiological, and psychological recovery. During this period, the coach and athlete can collaborate on the following items:

A. Completely evaluate the year's end functional capacity of the athlete.
B. Evaluate the previous year's training and gauge the effectiveness of the previous preparation phase.
C. Formulate the exact plan for the next year and include specific activities relative to intensity-duration flow patterns.

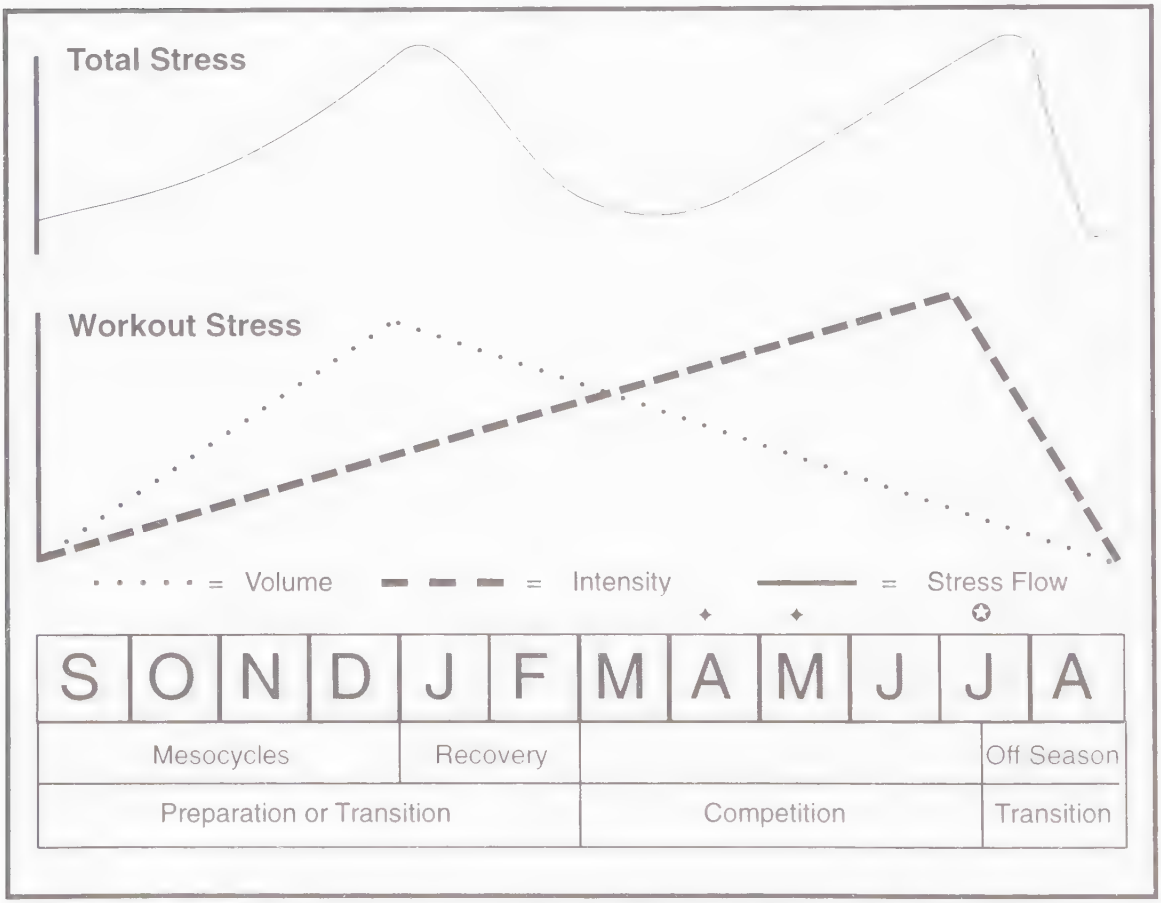

FIGURE 3.3 The annual monocycle showing the stress flow and the relationship between volume and intensity in relation to the main competition of the year.

The Flow Pattern

The flow pattern involved during the preparation and competition phases involves the relationship between intensity and volume. In Figure 3.3, the upper portion illustrates these flow patterns in relation to the training year. The intensity in the flow pattern gets progressively greater with an unloading period of approximately one mesocycle. There is a secondary progressive increase and peak in total stress just prior to the major competition of the year.

Note that the volume of training is greater during the preparation phase, while intensity becomes more important in the competition phase. Although no individual training units have been discussed, it is the flow pattern during various training phases that must be understood.

As can be observed from Figure 3.4, the volume is reduced and the intensity is increased to a peak, thereby fine tuning the athlete. This course translates into an outstanding performance. During the fine tuning process, it is also important to manipulate work/rest variables so that there is a recovery microcycle (or taper) if a peak performance is to be achieved.

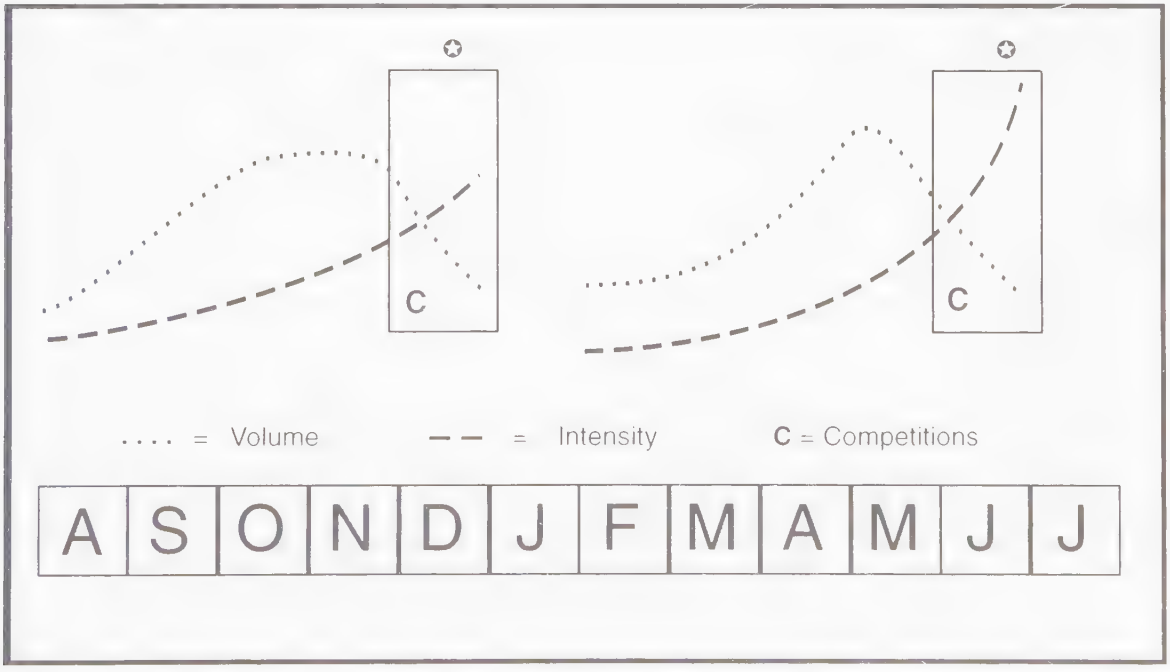

FIGURE 3.4 A calendar year showing two peaks with a recovery period between them.

Usually the attention will focus on preparation for one peak or one major competition. Athletes, however, may have several major competitions where the competition phase may be extended in length. The important point to remember is that the time period of volume and the intensity of training are reduced with a second progressive increase leading to the second competition phase, as is illustrated in Figure 3.5.

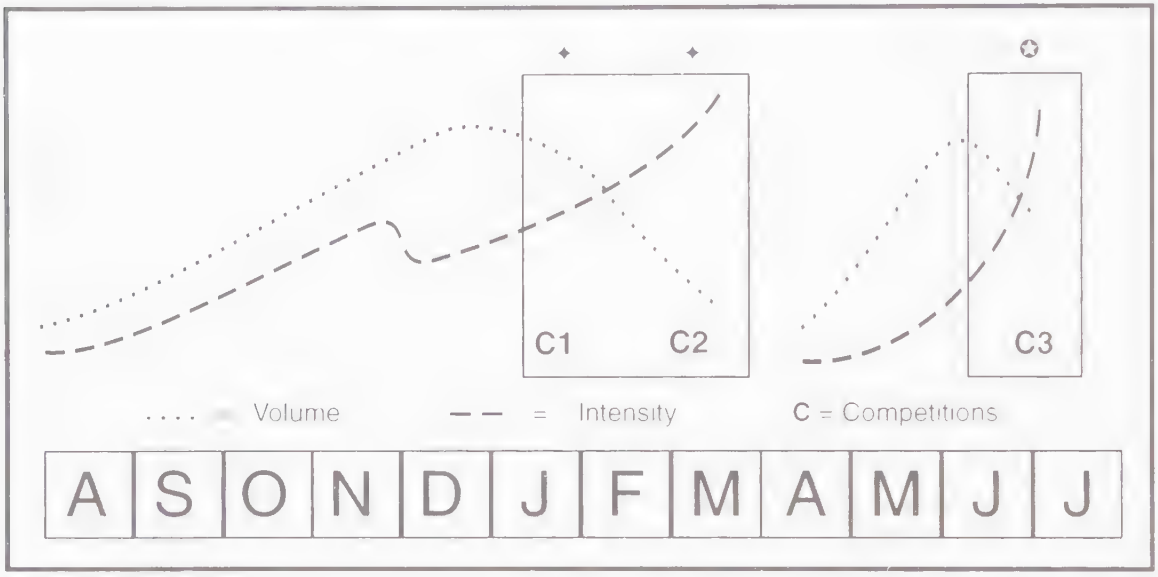

FIGURE 3.5 Two competition phases subdivided by a recovery/transition phase of short duration.

The reason for the reduction is to decrease the potential for set backs due to overstress of an extended competitive phase. In some eastern European countries, the annual cycle can be divided into as many as 6–7 short preparatory competition phases of different lengths. This concept is illustrated in Figure 3.6.

Notice, in Figure 3.6, that the preparation and competition phases are separated by a transition phase which serves as a period of unloading or restoration of the physiological systems. Short recovery in both intensity and volume can also be observed at the end of each base training and competition mesocycle. It is the recovery period which allows positive cumulative efforts to occur. Notice that recovery is incorporated into every mesocycle. A special taper in both intensity and volume also precedes each major competition. Also, observe total stress load and flow patterns of both intensity and volume and the interrelationship to each other. All early competitions are considered as preparation for major competition, and they become less frequent as the major competition approaches.

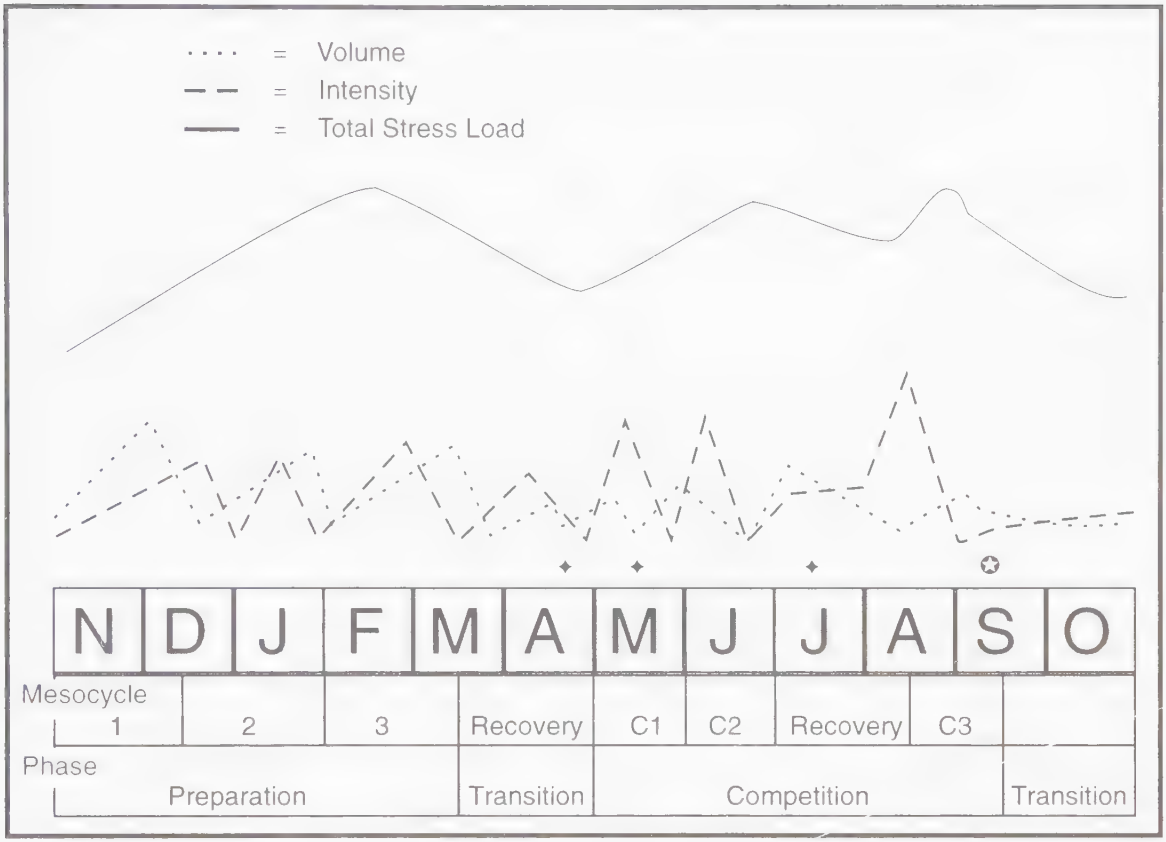
Major Competitions
= Volume
= Intensity
= Total Stress Load
N D J F M A M J J A S O
Mesocycle
1 2 3 Recovery C1 C2 Recovery C3
Phase
Preparation Transition Competition Transition

FIGURE 3.6 The annual cycle illustrating a number of peaks during the year, culminating with the major competition.

As described in Figure 3.7, I would like to briefly describe the training modes as they relate to training distances.

A. Aerobic base is divided into basic endurance, which is overdistance training and pace endurance. This has a segment of race-pace training plus basic endurance.

B. Aerobic power is divided into three types of training; sub-distance training (speed), race-pace training (specific endurance), and basic endurance training.

C. Speed endurance includes both sub-distance training and race-pace training.

D. Speed training with sub-distance training.

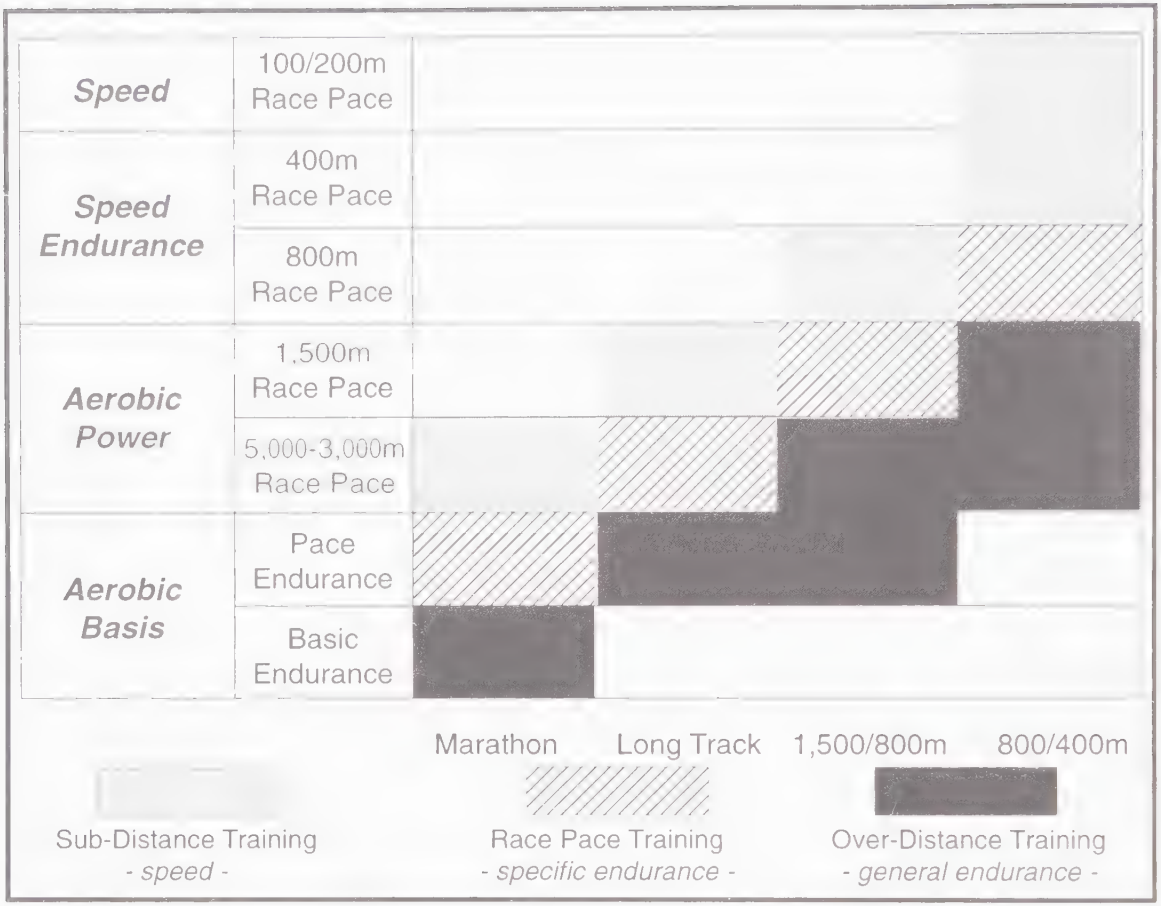

FIGURE 3.7 Intensity levels in endurance training of different running events.

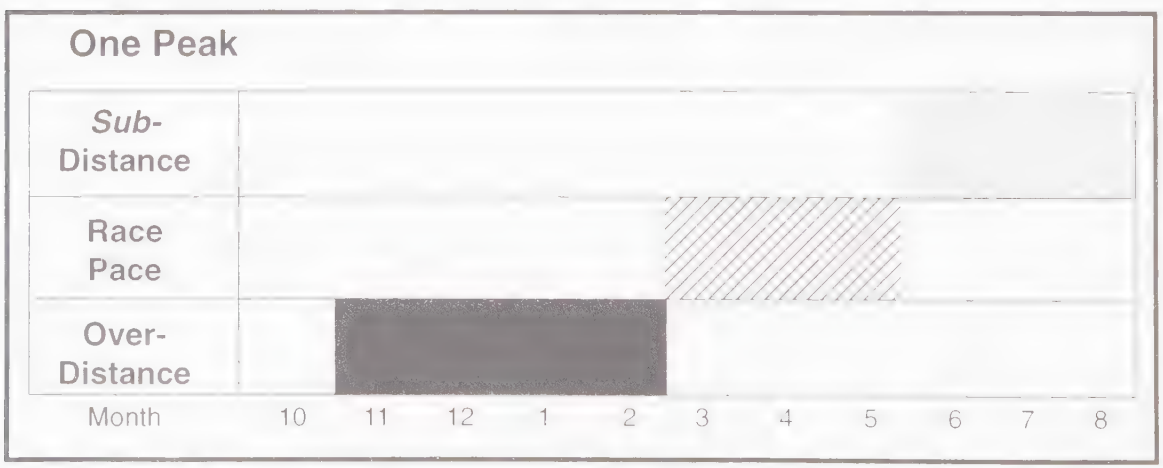

FIGURE 3.8 Deals with a traditional training period, long cycles. The ninth month, which is deleted, constitutes a transition (rest) month.

Figures 3.8 through 3.11 display the types of training necessary for a one peak, two peak, multi-peak, and a typical high school program. A period of time should be spent on these charts to study the types of training necessary to bring about a peak.

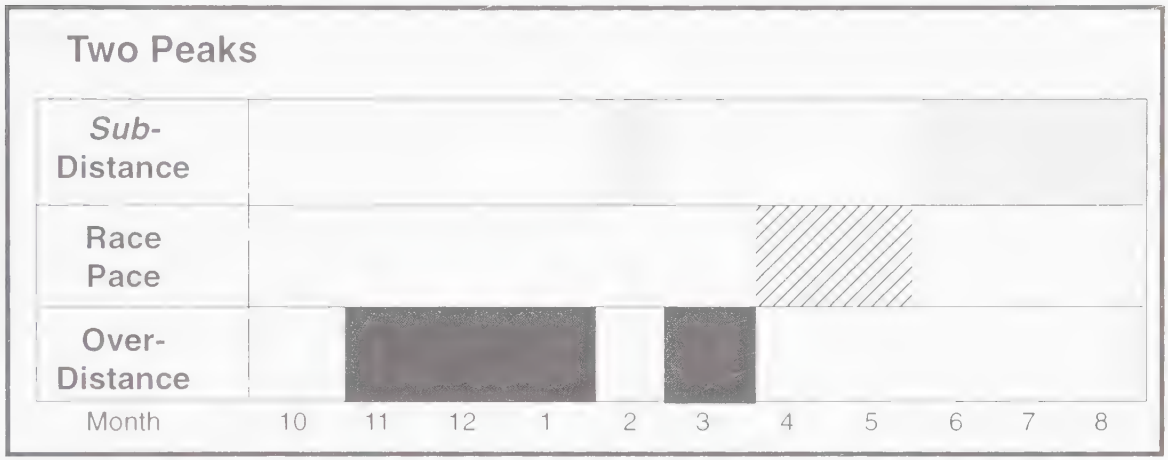

FIGURE 3.9 Training modes to develop two peaks during a training year. One peak is achieved in February, the other in August. Note the length of time devoted to overdistance, race pace, and sub-distance training.

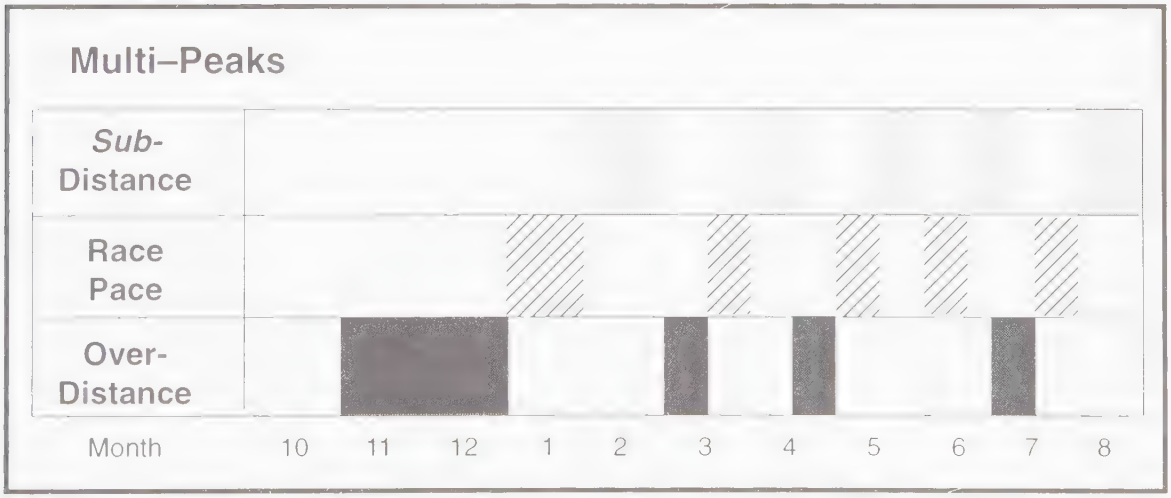

FIGURE 3.10 The type of training necessary to prepare the athlete for multi-peaking (5 peaks) during the year leading to the major competition of the year in August .

Coaches, psychologists, physiologists, and all people involved in athletics agree that, in almost every aspect from biomechanics to physiology, individual differences exist in adapting to the training stresses imposed. The principle of individual variability is not practiced in earnest if coaches put all their athletes in one group for workouts based on event(s) and age. There are those talented athletes who may complete their training session with ease, while those less talented may find it exceedingly difficult and be unable to complete the workout. In both cases, this is wrong. The first case results in undertraining and under realization of potential. The second can lead to rapid exhaustion, poor training and competition performances and possible injury due to overtraining.

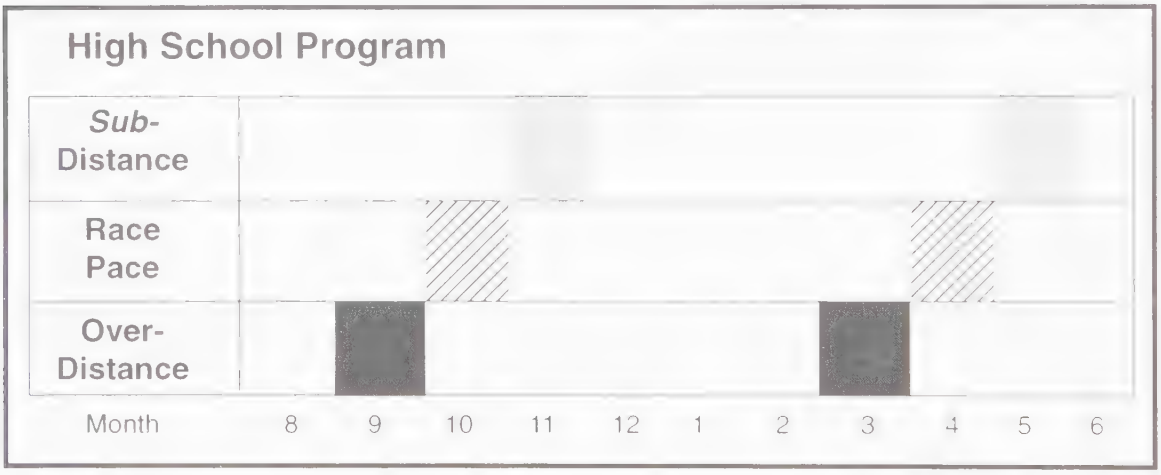

FIGURE 3.11 Typical high school training program where a peak is reached in November for cross country and another in May for track and field season.

The importance of individualization of training cannot be overstated. The coach and athlete must believe that the path to their training and performance goals can be reached even though each athlete within a group has a modified workout. After determining individual need, the application of increased loads and recovery at the appropriate time allows each athlete to reach his/her competitive peak at the desired time. Those athletes who adapt to workouts slowly do not have as great an opportunity for racing multiple, competitive peaks. Therefore, individualization of loading becomes more critical as the stress flow approaches an athlete's functional capacity.

Study Guide

1. What is periodization?
2. What is meant by the continuity of training?
3. Understand the concepts of microcycle, mesocycle, and macrocycle.
4. What is accomplished in the three phases (base, competition, and transition) of training?
5. Be able to differentiate between training and performance goals.
6. Understand the difference between immediate, residual and cumulative effects of training.
7. What is the difference between a test and a performance marker?
8. How should an athlete set up a calendar year?
9. What is the relationship between the flow pattern in training and peaking?
10. Describe the stress load in a training year.
11. Understand the concepts of overdistance, race pace, and sub-distance training.
12. Describe single peak, double peak, and multi-peak training within a calendar year.
13. What is the principle of individualization?

No better example of team camaraderie than after a National Championship victory in cross country where the proper mental and physical peaking led to victory.

4 Concepts Necessary for Success

"One of life's most painful moments comes when we must admit that we didn't do our homework, that we were not prepared."
- Merlin Olsen

Overview

The preparation to be successful contains many physiological and psychological concepts. Of the physiological ideas, understanding gradual adaptation to progressive training loads, overcompensation, and recovery time periods are important. One also needs strength of mind to have the determination, patience, beliefs, discipline and intelligence to carry through years of training. Additionally, the proper environment for training is a key factor in the success of athletes.

Introduction

Although I have mentioned many physiological concepts in this chapter on the physiology of running, a coach has to make a few constant reminders because running can be so mental and athletes easily lose focus. There are many occasions where these concepts are meaningless unless applied, discussed, or practiced at the correct time in their training. It is the coupling of the physical and the mental that develops the "mind-body" autonomy which gives way to success in running.

The development and nurturing of these concepts has always been a difficult task. Many elite as well as developing athletes have to be oriented on their view of successful participation in athletics. The coach and athlete must develop the creativeness and imagination to employ the items listed. At Adams State College, the informal discussion that took place during team meetings was the best time to discuss these valuable concepts. Whether they were freshmen or seniors, years of continuous bombardment of ideas eventually allowed those ideas to become deeply ingrained in the nature of the athlete.

1. The body will adapt to gradual and progressive loads.

When a new stimulus or a different activity is introduced, the intensity of training is increased. The stimuli must be well within the capability of the athlete. If this occurs, higher levels of adaptation and, consequently, higher levels of performance can be noticed. Also, keep in mind the principle of individual variability where an athlete will adapt at his/her own pace and not someone else's. This explains why some runners respond much quicker than others to similar training loads. Young athletes must be prepared to wait several years before starting to realize their full potential.

I can remember many of the freshmen 800 meter runners would marvel at the juniors or seniors who were running 1.48 or 1.47. They would ask "What's wrong coach? Why can't I run that fast? What do I need?" I would reply "all you need is time." Two or three years later, after covering many thousands of miles of training, completing hundreds of training sessions and gaining valuable experience in many competitive situations, they were running sub 1:50 800 meter times. The physiologic benefits they acquired could not be gained in a few weeks or months, so it was an excellent lesson for athletes to be patient and allow the body sufficient time to adapt gradually to the stresses of training.

2. The body does not just adapt – it overcompensates.

If the stimulus of the training load is of sufficient strength, the cell/organ/system will respond by fatiguing below its normal biological state (refer to Figure 2.1). Almost immediately after the stimulus, the compensation to the fatigue state will occur. This is a period where the cell/organ/system will replenish its energy stores, oxygen, and any other metabolic substrate which has been used during the period of stimulus. During the compensation period, the reaction is such that it will exceed the normal biological state and greater stores of energy will be available during the next stimulus. This allows the athlete to handle heavier work loads, if necessary. The body's ability to overcompensate means that very rarely is one able to tap physical resources to the full.

3. The body needs time to adapt and recover.

The body needs time to recover between training sessions and to plan when one runs hard or easy during the various microcycles or mesocycles. There is also a need to incorporate planned periods of easy running into the training. Many athletes think that training hard day after day will make them better runners, but the

truth is that a day off may do them more good than another hard day of training. Runners should not confuse the necessity for taking it easy and having a recovery day (or period) with not training because it is raining, too cold, or they just don't feel like it.

4. Possess Great Determination.

Athletes must have the ability to push their bodies during training and racing far beyond the limits of their comfort zone. Distance running is one of those sports where the athlete has to experience prolonged pain in training in order to achieve satisfaction. We can all remember teachers, coaches and spectators saying that "they must enjoy their sport." I don't believe those people understand what it is to voluntarily subject the body to a series of fast hard repetitions in training without recovery, or to maintain a blistering pace during a 3000, 5000, 10,000 meters or cross country race, regardless of weather or terrain. To *enjoy* training is not really the appropriate phrase; to gain *satisfaction* or *fulfillment* from training is more appropriate.

5. Develop Patience.

All athletes must wait for results to come. Miruts Yifter was 40 when he won two gold medals in Moscow in 1980 after running for some 28 years. David Moorcraft was 30 years old when he broke the world record for 5,000 meters, 16 years after starting to run. Carlos Lopes was 34 when he won the Olympic gold in Los Angeles in 1984. The point to remember, as stated in Chapter 1, is that success in running is not achieved overnight and many of these athletes had been competing for 16 to 18 years before they reached their full potential. Be prepared for the psychology of the "long haul" in training to reach your top form.

6. Develop Belief.

Athletes must go into the sport believing that they can be successful. They must not have any doubt about what their mission is in the sport. All athletes must ascribe to the following principles:

- ✔ Have an unshatterable belief in yourself.
- ✔ Have an unshatterable belief in your coach.
- ✔ Have an unshatterable belief in your philosophy of life.

If you really believe the above principles, then you can be relentless in pursuit of your goal.

7. Develop Discipline.

All athletes must have the ability to develop a plan for their daily living and, then, stick to it. In this plan they must budget time for training as well as everything else in their daily lives. They must put everything in the proper perspective and not take from one activity to enhance another. The ability to adhere to such a program is a quality all athletes need.

Most great runners have revealed that their good results have occurred when they have maintained a planned routine for a long period of time. There are many things such as injuries, family crisis, finances, and demands on time placed by others that can upset a regular routine. But the athlete has to face up to these problems sensibly, expect them occasionally and return to the daily regime as soon as possible.

The ability to budget time for a training program within their daily lives is the quality all athletes need.

Most great runners have revealed that their good results have occurred when they have been able to maintain a planned routine for a long period of time.

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8. Develop Intelligence.

There are two types of intelligence, crystallized and fluid. Crystallized intelligence is when the athlete knows what it takes to be successful and develops the native cunning to do it. The second is fluid intelligence, when the athlete actually carries out the plan. Most athletes know what it takes, but to actually do it is another matter.

All athletes spend considerable time training and developing racing tactics for a particular race but, when in the race, proceed stupidly and produce a result that is nowhere near their potential. The athlete possessed that crystallized intelligence but did not practice the fluid intelligence to carry it out in the race. There have been many runners who fall short of an ideal performance. This should not cause them to worry because there has never been a perfect performance.

9. Develop the Proper Environment for Training.

The ability to train properly depends to a large extent upon personal circumstances, and there are five factors I believe are extremely important to consider as athletes begin to organize their programs.

A. Time

Understand that you must fit in a block of time for your training. Initially, you will probably train only once a day. This will take 60–90 minutes but, as you develop, you might have two sessions a day encompassing three hours total each day. Athletes must commit to allocating this time to their training.

Athletes should allow at least 3–4 hours between workouts. In addition, you must eat within 60-90 minutes after the hardest work out to replenish your energy levels. It is also desirable to have an hour of relaxation after the workout. The distance of the workout site from home is another time factor. Getting there and back involves a period of time that must be incorporated into the day's schedule. An athlete might be a full time student or have a full time job, and those two conditions will influence when the major workout will occur. Weather conditions may also influence workout times. The weather may be hot and oppressive and you may want to work out earlier in the day or later in the evening. As you can see, the time factor is extremely important. I might add that only a few of the world's greatest runners have enjoyed ideal training conditions. Take the hand that has been dealt to you and make the best of it.

B. Background Support

It is extremely important for all athletes to have a relaxed and supportive system for training and competing. To have this background of support is a great asset. In a domestic setting, parents, husbands, wives, brothers and sisters can all contribute to positive experiences for a runner. There are so many things which runners need – from having clean training clothes to eating balanced meals to hearing encouraging words about what he/she is doing. These things can help spark greater enthusiasm.

We all realize what an over–ambitious support system can do to an athlete. All an athlete needs is an environment of people who understand what is taking place and who try to develop a settling atmosphere for the athlete. If he/she has a job or is going to school, it is extremely important for communication to take place so that teachers and employers can also encourage the individual athlete's goals.

C. Facilities

All athletes need variety in their training facilities–paved roads, dirt roads or trails, wooded areas, parks and, above all, a good quality synthetic track. Having access to these training grounds should facilitate the development of a good training plan.

During inclement weather it is easy to substitute one training site for another. In addition to the above areas, it is also important to include a good hill workout site. We are fortunate in Alamosa because we have access to all the training sites mentioned. We have mountain trails, sand dunes, undulating dirt roads, an excellent synthetic track and a lot of grass areas, all at altitude.

D. Coaching

Everyone needs a coach. A good coach can help in so many ways and have an important part in helping the athlete achieve his/her goals. There are many qualities which a coach must possess. The following are some of the things which I have used to help athletes reach their potentials.

1. A coach must be thoughtful and imaginative.

2. A coach will act as a tutor initially, and then eventually allow the athlete to introduce his/her ideas into the plan.

3. A coach must have good technical and practical knowledge in all aspects of running.

4. A coach must be able to communicate this knowledge and experience to the athlete.

5. The athlete and coach eventually become a team and share in all aspects of training and proper direction for living.

6. A coach must be able to assess ability and determine a person's potential.

7. A coach should inspire, motivate and lead the athlete in all training and competition.

8. A coach must never use athletes to further his/her own reputation.

9. A coach must be absolutely honest so that the athlete may be able to rely on his/her decisions.

10. An athlete must respect the coach's experience and judgment just as the coach must respect the athlete's ability and determination.

11. The coach and athlete must get along well, both on and off the track. It is vital to enjoy a good laugh together as well as discuss the technical aspects of training and racing.

12. A coach should be a guide, philosopher and friend. He/She must be positive and always constructive with criticism.

13. A coach must be enthusiastic and easy to talk to. This enthusiasm should be infectious and should lead to greater training and racing.

14. Above all, remember that if a good coach can stimulate an athlete, so can an athlete stimulate a coach to good coaching practices.

E. Training Partners

Athletes learn early on that good training partners are a real asset. At the same time, antagonistic running partners can be a nuisance and a hindrance. All distance athletes need partners on long distance runs and during difficult intensity days when fast repetitions are being practiced. In any relationship with training partners, it is important to remember not to compete with each other. I cannot emphasize this point strongly enough.

As you improve and no one can stay with you on long runs or track sessions, the phrase, " The loneliness of the long distance runner", becomes a reality. This is the price one pays for getting better. But there are many times when a person can run well within him/herself and enjoy training with teammates.

Study Guide

1. What is the significance of the law of progression?

2. Why is there a need for the body to adapt, and what is meant by organismic adaptation?

3. Why is there a need for patience?

4. Why is it important that everyone have a coach?

5. What factors should be considered in developing a proper environment for training?

6. Why is discipline necessary in planning goals?

Relays have always been important to Adams State track and field. Adams' runners were constant winners in the 4 X 800 and the DMR (Distance Medley Relay). Above, displaying the satisfaction and emotion of winners after completing the 1991 Indoor National Championship 4 X 800 (2 mile relay) are: (l-r) David Bell, Frank DeLeo, Brian Blazek and Martin Johns.

Variety in training environments is important for athletes who train the year around. These two photos are examples of hill training.

5 800/1,500 Meter Training

"You all have the powers you never dreamed of.
You can do things you never thought you could do.
There are no limitations in your own mind
as to what you cannot do.
Don't think you cannot.
Think you can."

- Darwin P. Kingsley

Overview

Because the 800 and 1,500 meter races are so similar in the percent of aerobic and anaerobic energies required, these two distances will be included together in this chapter. These training programs can be personalized to meet the needs of all ability levels. In addition, the relationship between volume and intensity is demonstrated while progressing through the three phases of training.

Introduction

The success in middle distance running appears to depend largely on the individual's combination of aerobic and anaerobic training and the athlete' s capacity and genetic talent. There is a great similarity in training the 800 and 1,500 meter runners. Consequently, both of these events will be discussed simultaneously in this chapter with sections describing technique, energy utilization, training, and tactics.

It was many years before I developed runners who could perform sub 1:50 800 meters and sub 4:00 miles at Adams State College. I was never able to understand and coordinate the four topics (technique, energy utilization, training, and tactics) and apply them to the athletes with whom I was working.

After about 15 years of coaching, I understood the complete integration of these four topics and applied them. The rest has become history. We have enjoyed watching runners in sub 1:50s and sub 4:00 minute miles every year.

I. Technique

To appreciate the full value of excellent fitness, all athletes must develop a good running technique. It is not a coincidence that all great runners (including world record holders from the 800 meters to the marathon) look good when they run. The aim of middle distance running technique is to be mechanically sound, efficient, and to develop good economic propulsion. Many coaches say that running is a natural activity and there is no need to worry about running technique. This assumption is wrong. Running may be a natural activity, but when running for a prolonged period of time, energy has to be channeled in the most efficient way possible. Middle distance events require saving energy and not wasting it. It becomes extremely important to eliminate all unnecessary body movements such as improper head motion, shoulder movement, flying arms, and improper leg lift. All of these inappropriate body movements waste energy and contribute to mechanical inefficiency. The following points must be considered in the development of sound running technique for both the 800 and 1,500 meter runs.

A. The mechanics of the lower leg motion are critical. This motion has four distinct actions.

1. The rear support and drive as you toe off the ground.

2. The rear swing where the heel of the foot approaches the buttock. The higher the heel the more intense the rear swing.

3. The forward swing, where you drive forward with your knee. Again the intensiveness is determined by the speed you are trying to achieve.

4. The forward support which should be only slightly in front of the center of gravity to inhibit over striding.

B. Middle distance running requires a relatively high speed. This requires the athlete to conserve as much energy as possible by using a shorter stride length and slightly reducing the stride frequency.

C. The appropriate stride length, stride frequency and a specific speed is determined by muscular strength, mobility, leg length, and neuro-muscular coordination.

D. The leg drive of middle distance runners is less intensive than that of sprinters. It continues to be less intensive as the distance of the race increases.

E. When the athlete has less intensive leg drive and stride frequency, the eccentric thrust is reduced, allowing the trunk to absorb most of the twisting momentum without undue assistance from the arms.

F. The trunk always remains upright at uniform speeds but develops a slight forward lean when the athlete accelerates.

To accomplish these techniques, good flexibility, strong stomach, leg and back muscles, good arm action, and good head position must be maintained no matter what the speed. The chapter on ancillary training will describe the activities necessary to increase good flexibility and strength to optimum levels. Figure 5.1 illustrates above mentioned lower leg motions A — points a-d.

II. Energy Utilization

The big question for any middle distance runner (800/1,500) is "What is the best way to run the race?" Start slow–finish fast, start fast–maintain, or even–pace? The 800 meter run has been referred to as the most unforgiving of all track events. It is almost impossible to make a mistake during the race and make up for it later. In the 1,500, small mistakes can be corrected during the 3 3/4 laps. The longer the race, the greater opportunity to recover from errors made while competing.

All middle distance runners must have aerobic and anaerobic expertise about their training and what is required in the race they are running. There are many runners who have started too fast and tired in the latter stages of their race because they did not run the race they prepared for. At the same time, there are runners who started too slow and finished in a flurry but were not able to catch their opponents soon enough, nor did they run the time they expected. The relative percentages of aerobic to anaerobic energy needs are universal, as indicated in Figure 5.2.

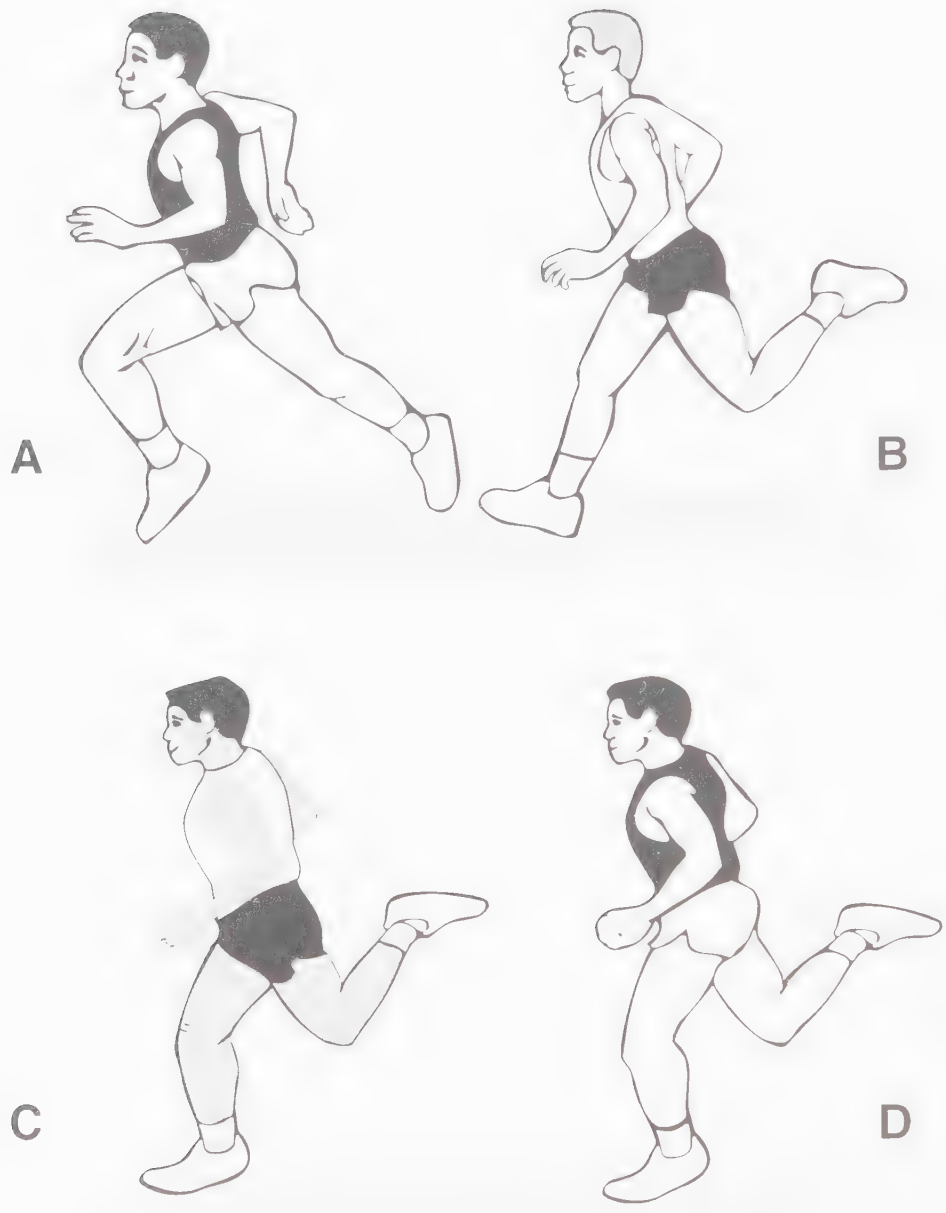

Figure 5.1 The mechanics of lower leg motion illustrating the analysis of runners displaying 4 basic movements: a) The push off; b) Butt kick (where heel swings towards buttocks); c) Forward drive with the knee; d) Forward support slightly in front of the center of gravity.

	Aerobic	Anaerobic
800 meters	45%	55%
1,500 meters	35%	65%

FIGURE 5.2 The percent of aerobic and anaerobic energies required to run the 800 and 1,500 meter runs.

Emphasis should be placed on the development of the athlete's dominating or strong suit. The faster type runners are advised to apply intensive training with a reduced load. Middle distance runners who display endurance qualities do less intensive training with a larger load. In his article on "Observations of 800 Meter Training," Karikosk states that there are three classifications of 800 meter runners :

1. Athletes exceptionally strong over 400 meters but relatively poor over 1,500 meters. Keep in mind that most good middle distance runners can all run sub 11.0 in the 100 meters.
2. Athletes capable of producing relatively good times, both over the 400 meter and over the 1,500 meter distances.
3. Athletes with strong endurance capacity who frequently have 1,500 meters for their secondary competitive distance.

It appears that relatively fast speeds are suitable for the training of athletes belonging to the first group. It is obvious that the neuromuscular system of the athlete belonging to this group can tolerate anaerobic work much easier but, because of their inefficient aerobic metabolism, react negatively to large training volumes.

Athletes in the second group train less intensively than the first group but employ a larger number of repetitions with shorter recoveries. Their metabolic system is much more economical and they have better energy reserves than athletes of the first group. Fatigue will set in much slower for runners in this group.

The athletes in the third group use lower intensities than the first group but have a very large training load. Their metabolism is economical, energy reserves are very large, and their oxygen transport is well adapted to long duration training.

It is essential that all middle distance runners develop sound aerobic and anaerobic training. This background, along with a clear understanding of the three characteristics stated on the previous page, will help them comprehend Table 5.3.

Group I	Speed - Creatine Phosphate --> ATP		100/200 meter distances all-out, heart rate (HR) 190-200 beats per minute (BPM).
		Carbohydrates	400/800 meter distances race pace HR 190-200 BPM.
	Speed Endurance		
		Lactate	
Group II	Speed - Creatine Phosphate --> ATP		100/200 meter distances all-out, HR 190-200 BPM.
		Carbohydrates	400/800 meter distances race pace HR 190-200 BPM.
		Lactate	
		Carbohydrates	800-3,000 meter distances at 3,000, 5,000, &10,000 meter paces HR 180-190 BPM.
	Aerobic Power	O_2	
		Lactate	
Group III		Free Fatty Acids (FFA)	15 to 30 kilometer runs HR 140-160 BPM.
	Aerobic Threshold		
		O_2	
		Carbohydrates	Pace endurance marathon race for 20 min. 160-180 BPM.
	Anaerobic Threshold		
		O_2	
		Carbohydrates	800 -3,000 meter distances at 3,000, 5,000, and 10,000 meter pace 180-190 BPM
		O_2	
		Lactate	

TABLE 5.3 The major energy systems and types of training employed in the three groups of 800/1,500 meter athletes.

Aerobic Training

Aerobic training occurs when the work being done takes place in the presence of adequate oxygen and is characterized by a series of physiological factors which include: increased hemoglobin (HG) and erythrocytes (RBC), an improved external respiration capacity, and cardiac heart output (CHO), which all lead to maximum oxygen consumption. It is this max VO_2 which is closely related to endurance performances and can be developed only under conditions requiring maximum cardiac output. Aerobic components (often called heart, endurance and anaerobic components) are referred to as muscular endurance.

The maximum oxygen consumption (Max VO_2), the minute volume of the heart, and the running speed all have a linear correlation at a heart rate of 130-180 (± 10). Often, some of the linear character is lost when VO_2 max reaches close to 100%. The heart rate, therefore, is a reliable guide for coaches and athletes. To understand this more completely, refer to Table 5.4.

Scale of Intensity	*Heart Rate*	*% VO_2 Max*
Maximum	190 +	100
Sub-maximum	180 - 190	90
High	165	75
Light	150	60
Low	130	50

TABLE 5.4 The relationship of heart rate to the percent of VO_2 max against a suggested scale of intensity.

When the athlete runs at speeds which exceed a heart rate of 150 beats per minute, a complex situation develops in which the aerobic system might be aided slightly by the anaerobic mechanism. As the heart rate increases upward of 165 BPM, the run becomes a combined aerobic and anaerobic activity.

The heart rate becomes the determinant in all training methods and the individual's physiological efficiency can be classified and developed either as aerobic or as anaerobic, according to the prescribed working heart rate.

1. Heart rate up to 130 includes warm up and cool down runs.
2. Heart rate of 130-150 includes warm up runs and light cross country running during active rest phases. This activity can last up to several hours.

3. Heart rate of 150–190 includes long steady runs lasting up to one hour, fast cross country runs with heart rates of 160–175, and repetition runs of 1,500 to 3,000 meters at heart rates of 170–190.

The yearly training cycle of all middle distance runners should include a volume distribution of 80–85% aerobic and aerobic/anaerobic work and 15–20% anaerobic work. The preparation (base phase) should include more aerobic training. As one gets into the precompetitive and competitive phases, the work load should show a steady increase (principle of progression) of 150–190 heart beats. Table 5.5 displays the aerobic, aerobic/anaerobic, anaerobic volumes during the precompetitive and competitive seasons of some of the world's greatest 800/1,500 meter runners. You can see that the 80–85% volume certainly holds true.

AVERAGE WEEKLY TRAINING VOLUMES (km)

ATHLETE		AEROBIC	AEROBIC/ANAEROBIC	ANAEROBIC
Rudolf Harbig - BEL	P	30	11.5	-
	C	25	2.1	2.3
Mal Whitfield - USA	P	27	11.0	2.6
	C	22	2.8	4.2
Roger Moens - BEL	P	65	5.8	2.8
	C	31	3.4	5.6
Tom Courtney - USA	P	21	13.2	1.8
	C	15	1.2	4.5
Peter Snell - NZ	P	126	32.0	-
	C	36	18.0	5.8
Ralph Doubell - AUS	P	65	16.0	3.4
	C	45	8.0	6.0
David Woddle - USA	P	84	53.0	0.8
	C	59	10.4	5.3
M. Fiasconaro - IT	P	29	18.8	3.7
	C	20	8.4	5.2
A. Juantorena - CUB	P	21	20.4	3 5
	C	19	7.0	6.5
Steve Ovett - GBR	P	99	47.0	2.9
	C	28	23.0	4.6
Sebastian Coe - GBR	P	72	24.0	2.4
	C	32	33.0	6.4
Joaquim Cruz - BRA	P	56	44.0	0.8
	C	40	1.2	7.2
Willie Wuhlbeck - GER	P	66	66.0	1.0
	C	32	21.0	5.7

TABLE 5.5
P = *Precompetitive*
C = *Competitive*

Training volumes and energy systems employed during precompetitive and competitive seasons by some of the world's greatest 800/1,500 meter runners.

Anaerobic Training

Sports scientists and coaches have determined that there are no entirely anaerobic training methods. The running of any distance event involves a certain amount of aerobic processes (Refer to Figure 5.2). The aerobic method of training is determined by the amount of oxygen debt and the concentration of lactic acid accumulated (3-4-5 mM). This justifies the differences in training during the preparation and competitive phases.

It is important to develop the highest possible VO_2 max during a calendar year before embarking on anaerobic training. In developing the aerobic processes, the emphasis is to improve the cardiac output and oxygen consumption by adjusting the workload according to the heart rate. The heart rate is unsuitable for deciding training loads in the development of anaerobic processes. In this case, heart rate serves only as a guide for recoveries.

The anaerobic development is determined by progressive adjustments toward higher oxygen indebtedness and lactic acid tolerance (Table 5.6). These physiologic processes can be checked using complicated instrumentation. However, the results obtained by examining the state of these physiologic processes are available in a very short period of time (one minute or less) and can be used to adjust the workload intensity up or down as the testing results would indicate. In the past, the results could be obtained only after many hours of waiting. This improvement in coaching methodology is extremely valuable if used properly. Many coaches and international federations are employing these methods, which is why their distance athletes are progressing at a faster and higher rate than are Americans.

Type of Training Concentration	Heart Rate	Blood Lactate
Aerobic or base	140 - 160	2mM - 3.5mM
Anaerobic training	160 - 180	3.5mM - 5mM
Aerobic Power	180 - 190	5mM - 8mM
Sprint Training	190 - 200+	10mM - 20mM

TABLE 5.6 Classification of heart rate and lactic concentration in relation to different training methods.

Training loads can be successfully set according to the running speed, the number of repetitions, and the length of recovery.

III. Training for 800/1,500 Meters

The training and competitive goals chosen will determine the training methodology to be used. The 800/1,500 events, like all distance events, involve year-around training. One purpose of this chapter is to show what major objectives must be included in training to arrive at a higher level of performance than in the previous year of training.

Reference Point Training (RPT) is a concept that I have developed to employ the intensities in training based on personal best for the previous season or what can be realistically accomplished this season. In his work on training theory, Vern Gambetta, former editor of Track Technique, coined the SAID principle (***S**pecific **A**daptation to **I**mposed **D**emand)* which states that it is impossible to run a specific time or goal unless the body has adapted to the training loads required by the specific time in mind. The RPT and SAID provide for this adaptation.

MONTHLY TRAINING VOLUMES - Middle / Long Distance

	Minimum	*Maximum*
800 – Ability	180 km 112 miles 1:47	632 km 392 miles 1:41.7
1,500 – Ability	250 km 155 miles 3:43.8	550 km 341 miles 3:31.66
5,000 – Ability	350 km 217 miles 14:21	650 km 403 miles 13:00
10,000 – Ability	392 km 243 miles 28:50	739 km 458 miles 27:08
Marathon – Ability	720 km 446 miles 2:12	960 km 595 miles 2:07

In almost all cases, the closer to maximum volume the closer to the highest ability level.

TABLE 5.7 A comparison of monthly training volumes and approximate ability levels in the middle and distance events.

The training year has to start with the athlete's basic preparation (described in Chapter 3). A firm grasp on the proper methodology to develop this base can be obtained by a careful review of Figures 3.2 – 3.11.

The *volume* in kilometers run during this base phase is higher than during the precompetitive and competitive phases (Table 5.5). Table 5.7 gives the approximation of monthly volume that has been successfully accomplished by world-class middle and distance runners. One can adapt the volume necessary to fit the situation.

Beginning or junior runners cannot immediately accomplish this volume, and the athlete and coach should develop a four to eight year plan to reach this volume goal. The volume achieved would be determined by the athlete's present condition. The recommended volume presented is for most junior and post-secondary runners and, in many cases, collegiate runners who fit into the ability levels described. These volumes are listed in Table 5.8.

Volume training throughout the year is necessary but the interrelationship between volume and intensity must also be considered.

TRAINING VOLUME / Miles Per Week

Age	*Men*	*Women*
Grade School	20	20
Junior High School	30	30
10th Grade	40	30
11th Grade	45	35
12th Grade	50	40
Post High School		
1st Year	70	40
2nd Year	80	50
3rd Year	90	60
4th Year	100	70

TABLE 5.8 Recommended weekly training volumes for middle distance runners.

I recommend that during the base or preparation phase there be a decrease in the volume as the training year progresses. 100% of the volume is recommended, followed by 80% of volume during the precompetitive phase. Finally, 50–60% of the volume is recommended during the competitive portion of the season. A reduction in volume is necessary and allows increases in intensity for the prescribed levels dictated by the athlete's goals.

The intensity of runs during the preparation phase is very important. The intensity must bring about a training effect. It is this intensity that marks the difference between the "fun–runners" and the competitive athletes. To find your own individual training threshold, and to ensure that a fair proportion of your steady state runs are at or above this threshold, carry out the following guidelines:

1. With the help of your coach determine your maximum heart rate.
2. Determine your basal heart rate just before you get up in the morning.
3. Deduct the basal heart rate just from the maximum heart rate and determine two–thirds of that figure.
4. Add the result of the two–thirds to your basal heart rate and this is your training threshold rate.

Example:

Step 1: Maximum heart rate is 200 beats per minute (bpm)

Step 2: Basal heart rate is 48 bpm

Step 3: 200 (max heart rate) - 48 (basal heart rate) = 152
2/3 of 152 = 101.2

Step 4: 101.2 + 48 (basal heart rate) = 149.2 ($\pm$ 5 bpm)
Training threshold heart rate = 149.2

When running short runs of 5-6 miles, shoot for a heart rate slightly above the training heart rate threshold. On long runs from 10–30 k, use the training threshold heart rate.

The objective during the preparation phase is to run at an effective aerobic level for a long period of time without inducing an oxygen debt. Since all courses are not perfectly flat, and the geographical conditions are not always the same, heart rate fluctuations will develop. These changes do not detract from the main objective of the run. Rather they have a tendency to strengthen cardiorespiratory processes and improve the economy of running up and down the hills. Accepting these points, one can continue to develop the aerobic system without adhering strictly to steady state runs. One can also run repetitions without incurring an oxygen debt by running 6–8 x 1000 meters, or 4–6 x 1 mile with a recovery period of three minutes.

The long and gradual build up which enables an athlete to hold on to the endurance factor, also allows him/her to improve it. It is this improvement which allows for the more intensive speed and endurance in the precompetitive and competitive phases to follow. During this preparation phase, it is very important that one judiciously increase the distance and number of runs and the pace of runs. It is also extremely important that, during this preparation phase, a small amount of anaerobic training and speed training takes place. It is wise during all phases to stimulate the fast twitch fibers and to remember that anaerobic energy systems also have to be developed.

Recall from the chapter on periodization and further study of Figures 3.2 through 3.11, that, whether the base period is one month or five months long, the same principle of the preparation phase applies. With this in mind, I have prepared a sample base preparation which can be applied to all levels of running. Table 5.9 illustrates the program used successfully at Adams State College for many years. These recommendations, along with a creative imagination, led to many National Cross Country Championships. Whenever the season is shorter or longer, the preparation phase can be adjusted accordingly.

PREPARATION PHASE

AUGUST	*SEPTEMBER*	*OCTOBER*	*NOVEMBER*	*DECEMBER*
Aerobic 100%	Aerobic 90%	Aerobic Increased Load 2 weeks	Aerobic Increased Load	Aerobic 4 weeks Reduced Load 1 week
Lower end of aerobic scale	Medium aerobic 5% High aerobic 5%	Low 80% High 20% 1 week Reduced Load	Low 75% High 25% 4 weeks	70% Medium 30% High Level aerobic
Just above training threshold	Medium & High Higher than the training threshold	Anaerobic speed & technique 2 weeks	Anaerobic speed & technique	Anaerobic speed & technique

TABLE 5.9 The preparation phase utilizing gradual increases in aerobic running and incorporating the gradual introduction of aerobic training.

The plan shown in Table 5.9 should allow for one easy day a week and two days (Monday and Thursday) of increased pace. There should be a progressive increase in volume and intensity throughout the preparation phase.

Table 5.10 illustrates the type of intensity run one should attempt once every two weeks to test oneself over volume at increased intensity. The alternate week should incorporate a cross country race, track race, or time trial. It may take five years to get to the international level. If the athlete is already there, it may take five months of aerobic phase. Certainly, just to get there is an excellent test of aerobic strength. It is this strength that one tries to maintain throughout the season.

800/1,500 METER TRAINING –15k Run – Once Every Two Weeks

Levels	*Local*	*Collegiate*	*National*	*International*
Reference Point Goal for 1,500	70% effort 9.4 mi/15k	80% effort 9.4 mi/15k	90% effort 9.4 mi/15k	100% effort 9.4 mi/15k
3:30	71:25	62:30	55:00	50:00
3:35	72:51	63:45	56:40	51:00
3:40	74:17	65:00	57:46	52:00
3:45	75:71	66:15	58:53	53:00
3:50	77:08	67:30	60:00	54:00
3:55	78:57	68:45	61:07	55:00
4:00	80:00	70:00	62:13	56:00
4:05	81:25	71:25	63:20	57:00
4:10	82:51	72:30	64:26	58:00
4:15	84:17	73:45	65:33	59:00
4:20	85:43	75:00	66:44	60:00
4:25	87:08	76:15	67:46	61:00
4:30	88:34	77:30	68:53	62:00
4:35	90:00	78:45	70:00	63:00
4:40	91:25	80:00	71:07	64:00
4:45	92:51	81:15	72:13	65:00

- Altitude Adjustment 4-5 seconds per 1,000 meters -

TABLE 5.10 Four levels of aerobic strength based on your reference point strength for 1,500 meters. The objective is to achieve the highest level possible during the preparation period and then maintain that level throughout the precompetitive and competitive phases.

Having recommended the training modality for base or preparation in middle distance training, we can now progress to the precompetitive and competitive phases of training. To this point, aerobic capacity has been developed as much as possible during the calendar year. It is now essential to maintain it while moving into the next phase of training. Refer to Table 5.10 and the recommendation to perform this run at the highest present level in order to maintain the aerobic strength developed.

There are an infinite variety of training methods which can be practiced as one goes into precompetitive phases of training. It is now time to develop speed and anaerobic capacity. I will discuss the major principle involved in hill training, interval training, tempo runs and sprinting, in the hope that all coaches and athletes will incorporate these methods during the precompetitive and competitive phases of training. We must remember that the emphasis be on an athlete's strong suit, developing strength at the same time some attention is given to the weak suit.

1. Hill training has been an integral part of many of the most popular training programs of Olympic champions and world-record holders in the middle distance events. Arthur Lydiard referred to it as one of the most important aspects of training. He was instrumental in developing aerobic and anaerobic components with the emphasis on anaerobic. The Finnish runners use it religiously as well as the Kenyan, Mexican, Moroccan, and Ethiopian runners who are presently revolutionizing times in the distance events.

Method:

Locate a hill area that has a grade of 5° to 15° over 100 meters. There should be ample distance to accelerate up the hill and an equal distance at the top to do some easy jogging/striding to recover before another repetition is attempted. Initially, the hill training period should last six to eight weeks with light running. This light work can include distances of hill running from 100 meters to 400 meters.

As the hill training period continues, the speed of the run up the hill should increase so that you are running as hard as possible toward the end of the hill training phase. The progression involved is similar to other types of training. If you start with eight to ten reps, increase the speed of the runs. Or you can start fast and increase the number of repetitions.

Our objectives during the hill training phase should be to develop:

- ✔ Power and muscle elasticity,
- ✔ Improvement in stride length,
- ✔ Improvement in stride frequency, and
- ✔ Improvement in coordination.

This will provide for optimal development of speed, power, and endurance as well as technical development and specific strength. Research has concluded that one of the best methods to develop strength endurance is to do uphill running. Other methods such as uphill bounding, running in deep snow, water or sand, and running into a strong wind can also develop strength endurance. Mechanically there will be a forward movement of the body and a strong and rapid upward thrusting of the swinging knee. The drive off of the rear support foot and ankle will be stronger. The arm action will be higher and more vigorous as it aids in propelling the weight of the body uphill. The best time to incorporate hill training is during the precompetitive phase before starting speed workouts on the track.

2. Interval training has become a very popular method of training world–wide. It is considered to be the best method of improving aerobic-anaerobic power. I believe it is most necessary for coach and athlete to understand the physiologic principles involved in interval training. By definition, interval training is the rhythmical performance of an activity from thirty seconds to three minutes at an intense effort, but not all out. Each repetition is followed by a ten-second to two-minute slow, recuperative period.

   These are the physiologic laws involved.

   The Law of Repetition requires that a specific number of repetitions be attempted and completed. Usually 1 to 2 1/2 times race distance is accomplished during the workout.

   The Law of Frequency guarantees that the body will adapt when the activity is repeated regularly over a mesocycle (4-6 weeks).

   The Law of Alternation (of effort) allows for a specified distance to be run at an intense speed. When the distance is completed, then one recovers with active rest (usually a jog) until it is time to start the next repetition.

The Law of Rhythm involves the body's adaptability to work, rest, or the number of repetitions to be attempted.

The variables and the physiologic laws to be considered in interval training are:

Distance: This is usually determined by the racing distance of the athlete and is classified as follows:

- Speed Intervals - 50 to 200 meters
- Faster than Race Pace - 300 to 800 meters
- Race Pace - 400 meters to mile
- Slower than Race Pace - 600 to 2400 meters

The tempo or speed of the intervals to be run is determined by the RPT (Reference Point Training) or the SAID principle, as has been described previously. The following Tables are a few examples of middle distance training intervals.

The interval workouts described in Tables 5.11 - 5.14 will cause the heart rate to raise to 180 beats per minute (±10). At this working intensity, the stroke volume is optimal. During the recovery the heart rate will decrease to 120 bpm, usually after 45 to 90 seconds or two to three minutes. At this heart rate, there is still an optimal stroke volume. If the athlete cannot achieve the times desired during the interval workout, or if the recovery time exceeds the above prescribed, the athlete must discontinue the workout.

800 METERS – Precompetitive Phase

Distances	*Time*	*Number of Repetitions*
100 meters	1 - 2 1/2 seconds slower than best effort over the distance	16 - 20
200 meters	Race Pace	12 - 16
400 meters	Race Pace	4 - 6
600 meters	4 seconds slower than Race Pace	4

TABLE 5.11 Interval workout for 800 meter runners during the precompetitive phase.

800 METERS – The Competitive Phase

Distances	*Time*	*Number of Repetitions*
100 meters	All out	10
200 meters	4 @ 30 seconds 4 @ 28 seconds 4 @ 26 seconds	3 sets of 4
400 meters	All out (5-8 minute recovery)	3
600 meters	Race Pace	3

TABLE 5.12 Interval workout for 800 meter runners during the competitive phase.

1,500 METERS – Precompetitive Phase

Distances	*Time*	*Number of Repetitions*
200 meters	Race Pace	16 - 20
400 meters	Race Pace	10 - 12
800 meters	Race Pace	6 - 8

TABLE 5.13 Interval workout for 1,500 meter runners during the precompetitive phase.

1,500 METERS – Competitive Phase

Distances	*Time*	*Number of Repetitions*
200 meters	2 seconds faster than Race Pace	12
400 meters	All out	5
800 meters	2 - 4 seconds faster than Race Pace	4

TABLE 5.14 Interval workout for 1,500 meter runners during the competitive phase.

3. Repetitious running for strength endurance has been one of my favorite practice sessions in all three phases of training; base, precompetitive, and competitive. It has also been the basis of the strength endurance our athletes have demonstrated over the years. We usually work at velocity at VO_2 max pace during cross country and at a percent of max speed during the precompetitive and competitive phases. The three distances employed are 800 meters, one to two kilometers, and one mile distances. The objective is to reach the time prescribed by the workout.

   The number of runs is as follows for middle distance runners:
   8 x 800 meters, 6 x 1 kilometer or 3 x 2 kilometers, and 4 x 1 mile.
   Examples:
   If an athlete has vVO_2 (velocity at Max VO_2) of 4:30/mile, he/she would run 4 x 1 mile at 4:30 pace. On the other hand, during the precompetitive and competitive phases, percentages of max speed are used.

   a. 1 mile x 4 with a three minute recovery interval. A 4:00 miler starts at 85% then 88%, 91%, and 94% over the 12 week period in the precompetitive phases.

      - 85% = 4:42 x 4 with 3 minute recovery intervals
      - 88% = 4:32 x 4 with 3 minute recovery intervals
      - 91% = 4:24 x 4 with 3 minute recovery intervals
      - 94% = 4:15 x 4 with 3 minute recovery intervals

   b. A 1 kilometer x 6 with a three minute recovery interval using 4:00/mile speed & subtracting 17 seconds equals a 2:30 one kilometer.

      - 85% = 2:54 x 5 with 3 minute recovery intervals
      - 88% = 2:50 x 5 with 3 minute recovery intervals
      - 91% = 2:45 x 5 with 3 minute recovery intervals
      - 94% = 2:40 x 5 with 3 minute recovery intervals

   c. 2 kilometer x 3 with 3 minute recovery interval. Because this distance is longer than a mile, one has to start out with a lower intensity and not progress as high as was achieved in the one mile and one kilometer repetitions. The base for 2 kilometers is 5:00.

      - 81% = 6:10 x 3 with 3 minute recovery intervals
      - 84% = 5:57 x 3 with 3 minute recovery intervals
      - 87% = 5:44 x 3 with 3 minute recovery intervals
      - 90% = 5:33 x 3 with 3 minute recovery intervals

d. 4-8 x 800 meters. Most of our middle distance runners run an 800 between 1:47-1:50. For the purpose of training using the repetitions method, we use a 1:50/800 meters base.

- 85% = 2:09 x 8 with 3 minute recovery intervals
- 88% = 2:05 x 6 with 3 minute recovery intervals
- 91% = 2:00 x 5 with 3 minute recovery intervals
- 94% = 1:57 x 4 with 3 minute recovery intervals

After studying the workouts just described, one can conclude that the volumes are very similar.

• Repeat miles approximately	6400 meters
• Repeat kilometers	6000 meters
• Repeat 2 kilometers	6000 meters
• Repeat 800 meters	3200 to 6000 meters

4. Speed endurance training is designed to produce a quality performance in the presence of the metabolic products, lactate and H ions. In any training plan, the goal is to increase the intensity as much as possible once the heavy competition season begins.

Examples:

a. Increase number of repetitions
6 x 200 early season
l0 x 200 meters late season

b. Increase intensity
10 x 200 @ 32 seconds with 75 second recovery
to
10 x 200 @ 32 seconds with 25 second recovery

c. Reduce number of repetitions
10 x 200 @ 30 seconds with 75 second recovery
to
6 x 200 @ 26 seconds with 75 second recovery

d. Reduce the density (recovery period)
From 75 - 50 - 30 seconds

This is all quality work and sometimes sets are used (2 x 5 x 200 etc.). This is also one of the hardest workouts to maintain control over, and it is imperative to maintain the quality of the variables throughout. If the objective is to vary the pace, step downs or accelerations can be used. It is necessary for a runner to be able to change gears during

competition, especially in the middle distance events. These two workouts allow for this.

Examples:

3 x 300 meters – 45 seconds – 100 meter recovery – (in 60 seconds)
3 x 300 meters – 42 seconds – 100 meter recovery – (in 60 seconds)
3 x 300 meters – 34 seconds – 100 meter recovery – (in 60 seconds)

– or varying distances can be used –

600 meters	–	109 seconds –	100 meter jogging recovery
400 meters	–	66 seconds –	100 meter jogging recovery
300 meters	–	46 seconds –	100 meter jogging recovery
200 meters	–	26 seconds –	100 meter jogging recovery
100 meters	–	13 seconds –	100 meter jogging recovery

5. Acceleration Workouts

- 100-200 run accelerations from 100 meters to 200 meters, starting with 100 meters and increasing 10 meters each interval etc.: 110, 120, 130 - 200 for a total of 1650 meters in the workout.
- Select best time for 1,500 meters and 400 meters
- 1,500 meters = 343 seconds = 4:00/mile
  4:00/mile = 60 seconds/400 meters = 15 seconds/100 meters
  The time for the 100 meters becomes the starting point.
- 400 meters = 52 seconds = 26 seconds/200 meters
  The time for the 200 meters becomes the speed of the last repetition.
- Subtract 100 meter time from the 200 meter time (26 - 15 = 11)
- Divide the answer by 10 (11 divided by 10 = 1.1)
- The workout is a high quality 1650 meter workout in which the athlete accelerates 1.1 seconds every 100 meters. This workout is also a good tactical way to run a 1,500 meter race. Refer to Table 5.15 for complete analysis.

1,500 meter pace											**400 meter pace**	
Distance	100	110	120	130	140	150	160	170	180	190	200	Meters
Time	15	16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	26.0	Sec.

TABLE 5.15 The speed and distance of each acceleration. After each acceleration the recovery is a jog back to the starting point of the next acceleration.

200 -300 meters

- Select best time for 1,500 meters and 400 meters
- 1,500 meters = 343 seconds = 4:00/mile
  4:00/mile = 60 seconds/400 meters
  = 30 seconds/200 meters
  The time for the 200 meters becomes the starting point.
- 400 meters = 52 seconds = 39 seconds/300 meters
  The time for the 300 meters becomes the speed of the last repetition.
- Subtract 200 meter time from the 300 meter time (39 - 30 = 9).
- Divide the answer by 5 (9 divided by 5 = 1.8) See Table 5.16 for analysis.

These acceleration workouts should be used at the end of the season, during the fine tuning period, so that the athlete can be razor sharp for his/her heaviest competition of the year.

	1,500 meter pace				400 meter pace		
Distance	200	220	240	260	280	300	Meters
Time	30	31.8	33.6	35.4	37.2	39.0	Sec.

TABLE 5.16 The speed and distance of each acceleration. After each acceleration the recovery is a jog back to the starting point of the next acceleration.

The five types of training to be considered during the precompetitive and competitive phases are hill training, interval training, repetitious running, speed endurance, and acceleration runs. Remember the primary objective of maintaining aerobic strength and the recovery that is needed in the day following a hard intensity workout.

The coach and the athlete must understand that no single training method will develop the total runner. It is only by skillful integration of all training methods and variations incorporated by the coach that the greatest adaptation can be approached and achieved. In addition, the training program for an athlete must be dictated by the following:

- The competitive demands of the athlete.
- The athlete's training status.

- The stage of development of the athlete (age, sex, anatomy, physiology, etc.).
- The long and short term goals of training.
- The limitations of the training environment.
- The demands of the nonathletic environment.
- The athlete's personality.

The following two microcycles can serve as examples of how one would incorporate workouts during the pre-competitive and competitive phases of the season.

Precompetitive Microcycle

Sunday	Long run 20-30 kilometers. Aerobic run.
Monday	Hill training to develop power and strength. The longer 400–meter repeats should be done earlier then terminate with shorter 100 to 200 meter repeats at a greater intensity.
Tuesday	Recovery run of one hour.
Wednesday	Repetitious running using the 2 kilometer and mile distances earlier and then the mile and 800 meter distances later on.
Thursday	Recovery run of one hour.
Friday	Short speed endurance workout.
Saturday	Early season run 15 kilometer distance. (Table 5.10) Competition or 20 minute anaerobic threshold run.

Competitive Microcycle

Sunday	Long run 12-20 kilometers. As the training nears the heavy competition phase, the volume of the long runs decreases.
Monday	Interval workout using longer intervals in the early season. Use shorter intervals as key competitions approach.
Tuesday	Recovery run of one hour.
Wednesday	Alternate repetitious running using the mile and 800 meter distances during the early portion of the phase. Switch to speed endurance and then acceleration workouts as key competitions occur.

Thursday	Recovery run of one hour.
Friday	Easy 30 to 45 minute aerobic run terminating with six strides of 100 to 200 meters at race pace for 1500 meter runners and 50 to 150 meter strides for 800 meter runners.
Saturday	Competition or time trial at greater than or shorter than race distance, or 20 minute anaerobic threshold run.

IV. Racing Tactics for 800 Meters

Every athlete must develop a race plan to be able to predict the performance capacity expected in the upcoming race. There are always two preliminary questions: is the athlete's objective to win the race or is it to record a fast time? In both cases the athlete must know his/her individual strengths and weaknesses as well as those of the opponents.

The training should have allowed the athlete to develop a combination of raw speed, strength, anaerobic endurance, and the capacity of split second judgment to exercise fluid intelligence during the course of the race. In the 800 meters, the short length of the race will not allow for any mistakes because there will be no time to compensate for it.

The race model you develop should help you establish sound patterns of thought that will help guide you through the unknown aspects of a race to create the best performances possible.

The following guidelines should be included in the plans for running a successful 800-meter race.

1. To establish a fast time, the performance potential is based on the athlete's ability to distribute the energy sources (aerobic/anaerobic) for the 800-meter distance.
2. Although it is desirable to establish an even pace throughout the whole race, efficient pace judgment is not always possible in a race where one finds experienced racers. The objective for the athlete should be to run his first 400 meters as close to 93% of maximum 400-meter

speed as possible and his second 400 meters as close to 89% of maximum 400-meter speed as possible.

Example: Maximum speed for 400 meters = 48.0
93% = 51.6
89% = 53.9
800 meter time = 1:45.5

The percentages listed are for properly trained (aerobic and anaerobic) athletes. Adjustments might be necessary for less accomplished athletes.

3. The athlete who has superior base speed has to set a sufficiently fast pace to drop off the opponent before the final sprint. If one does not possess sufficient speed, he/she must change the pace with sustained surges to wear the opponent out before the sprint to the finish.

4. The athlete should treat each race on its own merits. In other words, the tactics employed must be flexible to allow for unanticipated developments to occur as the race unfolds. One needs the capacity to react instantaneously.

5. Be alert at the start, conscious of jostling, spiking, or falling down. Always position yourself to be on the outside edge of the lead runners. Major races use staggered starts in lanes, but you must position yourself to jockey for good position as you drive toward the pole.

6. Remember to go out with good speed because it is always easier to *ease up* than to *speed up*. The 800 meters is often called a long sprint.

7. Run the shortest distance. Do not run the second or third lane unnecessarily. Remember always that "the shortest distance between two points is a straight line." If you fail to recognize and execute the plan, you may get into trouble.

8. As you prepare for the finish, muster all the courage at your command. Try to shatter the opponents' will at the same time you derive greater amounts of mental energy to charge to the finish.

9. You must be willing to commit completely and develop the confidence necessary. This comes from hard work during practice where you have developed the capacity to tolerate the pain of sustained speed as well as long distance running fatigue.

V. Racing Tactics for 1,500 Meters

The mental preparation for racing 1,500 meters can have some of the same attributes necessary for 800-meter racing. There is roughly twice the time span in the 1,500 meters. Although it is true that there is added time to recover from mistakes made while racing, there is, also, twice the time to place oneself in a difficult situation. All 1,500-meter runners must know themselves in terms of aerobic/anaerobic strengths. They must also know what final 400-meter time they can come up with from both a slow-paced or fast-paced race. The 1,500-meter run often becomes a slow tactical race, and it is often the athlete with the greatest speed during the last 400 meters who wins. It, therefore, becomes necessary for all 1,500 meter runners to include in their training plan the ability to develop the greatest 400-meter speed possible. The following principles must be understood for sound tactical racing.

Racing Tactics

1. It is necessary to position yourself early in the race because, with twelve to fifteen competitors jostling for position, you might encounter unexpected physical contact.
2. Remember that, once the race is in session, straight-line running for the pole on the backside is essential. Do not run unnecessary distances.
3. Maintain your rhythm. Do not let it be disrupted. It is your game plan, the one you trained for and one in which you have confidence. Many races are lost because athletes are forced to run someone else's game plan.
4. As with the 800-meter race, position yourself on the outside shoulder of the lead runner. To get boxed in behind runners is costly, both in terms of time and place of finish.
5. Your training must have included 400-meter sprints, faster than race pace, to provide you with the ability to sprint to the front if you happen to get boxed in. Remember that sprints that are too fast can be costly in terms of developing an anaerobic debt which will take away from the finishing kick. You must, however, have the capacity of good surging power or ability to shift gears.

6. We realize that a good steady pace is most economical. The fact remains that the victory will always go to those athletes who can manage great pace variations.

7. You must have the mental acuity to decide when to strike, because once the decision is made, there is no turning back. The finishing sprint should last until you cross the finish line.

8. You must always be conscious of the physical state of your opponents. Be able to detect when they are laboring or when their spirits are flagging so that you can take advantage of these situations.

9. The ability to surge and maintain your confidence throughout the race, regardless of what happens, and to be able to react to the developing situations, is perhaps the greatest tactical quality all athletes need.

There are many athletes who enter a race without a game plan and are not successful. The race tactics I have presented will not only guarantee the fluid intelligence necessary to run a successful race, it will also give the competitor the confidence that he/she is fully prepared to meet the challenge of the race.

Study Guide

1. What factors must be considered in developing good techniques in middle-distance running?

2 Differentiate between aerobic, aerobic/anaerobic, and anaerobic workouts for middle-distance runners.

3. What energy demands are placed on both 800 and 1,500 meter runners?

4. Categorize the three different characteristics found in 800 meter runners.

5. Discuss the volumes necessary for middle-distance runners and the relationships between volume and intensity in middle-distance running.

6. What is the importance of Reference Point Training (RPT) and the Specific Adaptation to Imposed Demands (SAID)?

7. Describe the difference between hill training, interval training, repetitions running, speed endurance, and acceleration workouts.

8. What are the basic differences in training between base (preparation), precompetition, and competition workouts?

9. Develop racing tactics for both the 800 and 1,500-meter training.

Julie Jenkins Donley. former American record holder in the 1.000 meter 2:34.6 and 1991 leader in the 800 meter 1:57.80.

Maurice Smith, Adams State College record holder in the 1,500 meter (3:34.6) and seven time National Champion while at Adams State College.

6 3,000 Steeplechase,* 3,000 & 5,000 Meter Training

"To conquer oneself is a greater task than conquering others."

- Guatama Budda

Overview

This chapter will discuss basic training plans for the 3,000 through 5,000 meters, including basic techniques and drills necessary for steeplechasing. If an athlete has a solid foundation of base (aerobic, aerobic/anaerobic and anaerobic), middle distance events can be run with great success. However, if preparing for a specific distance (event), athletes must train for the particulars of that event.

Introduction

The world records in the flat 3,000 meters, the 3,000 meter steeplechase, and the 5,000 meter runs respectively are 7:29.6 by Said Aouita, 8:02.08 by Moises Kiptanui, and 12:56:96 by Haile Gebresilasie. A tremendous pace must be maintained to achieve these marks. The flat 3,000 meters requires a sub-60 second pace per 400 meters for 7 1/2 laps. The 3,000 meter steeplechase requires a 64 plus seconds per 400 meters for 7 1/2 laps. This time is achieved in spite of the 28 obstacles and the seven water jumps the athlete must execute during the race. The 5,000 meter world record was set requiring a 62 plus seconds pace per lap for 12 1/2 laps.

The world records and pace for the 400 meters attests to the remarkable training of these athletes. As noted in the world all-time lists posted by the International Amateur Athletics Federation (IAAF) in its statistics handbook of 1993,

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** The 3,000 meter steeplechase is a 7 1/2 lap race (400 meters/lap) where the runner hurdles or jumps four 36" barriers and one 36" water jump per lap. The area of the water jump is 8' 12" feet. The water jump is 30" deep at the rear end of the barrier and slopes up till it is even with the track at the far end. The total number of jumps in the race is 35: 28 barriers and 7 water jumps.*

the three world-record holders are also near the top in all three distance events through the 10,000 meters. Also, all three of these athletes participate and excel in cross country, and either live or train at high altitude.

The IAAF world all-time list includes only one American in the top 25 in the 1,500 meters, one American in the top 25 for the 3,000 meter steeplechase, and two Americans in the top 25 in the 5,000 meter run. Further analysis of the American runners shows that few run cross country and that a very small number train at altitude. Other reasons for this demise are that the principles of athletic training for middle distance events are controversial and vary from country to country. Success in these events often depends on the athletes environment, national tradition, climate, social characteristics and general attitude toward sports.

The obvious answer to this apparent anomaly is that the basic principles and the fundamentals of periodization produce results when practiced religiously. There are many roads to Rome. The best one, however, is the straightest one. That straight road is the one the coach and the athlete understand the best. It is interesting to note how the training methodology is so often the reflection of the national characteristics.

Running the distance of 3,000 to 5,000 meters in national or world–class times requires an excellent training program where strengths and weaknesses of the individual athlete are understood by both athlete and coach. When these facets are considered and improved, the athlete will achieve high levels. One of the most important elements is to acknowledge the totality of the whole person. The coach, athlete, family, and friends must identify all the facets of the individual's aspirations and self perception.

For nearly three decades, my approach to training has been an eclectic one, combining the ideas of many others (including the empirical interpretation of their findings) and, of course, my own ideas and experiences. I am thankful for my own education in the life sciences and, in particular, the area of exercise physiology. I am indebted to people such as Dr. J.T. Kearny and Dr. Peter Van Handle, both heads of scientific services at the USOC in Colorado Springs, Colorado, for the physiologic testing and assessments of my athletes at Adams State College over the years.

In addition, I appreciate the research physiologists from whom I have derived the materials which have enabled me to coach many outstanding athletes, both domestic and international. The list of physiologists is too long to mention all, but,

to name a few, Astrand, Christiansen, Nielson, Karvonen, Costill, Fox, Magaria, and Saltin, have been helpful. From the very beginning of my research, it became clear to me that a magic solution to the search for ultimate success in middle and long-distance running did not exist. The more I searched and read, the more it became apparent that the balance weighed more heavily in favor of what we did not know as opposed to what we did know.

In my travels as a national coach, I have presented clinics all around the world. My curiosity and visits with coaches and scientists have revealed that it is necessary to produce a balanced program which will raise the development of all aerobic and anaerobic elements. There are also elements that do not fall into either camp, i.e. enthusiasm, team spirit, etc. In order to achieve the ultimate performance, it is important to provide correct union of these elements for any given individual, depending on the current stage of development.

Through all of these experiences, I devised a complete program composed of many parts. Not only did I identify the variables necessary in the pursuit of the ultimate performance, but I also investigated the elements of high intensity runners – the practice of running fast. Fast running has always been a dominant influence in my approach, and the Adams State College runners have continually carried this characteristic into competition. I have been labeled as a devotee of "under-distance" running as opposed to long, slow distance running. The basic label of my coaching style, of course, is much more complex.

Running fast, even though moderate intensity sessions are practiced, makes an athlete feel confident and inspired to run fast in races.

In order to run fast, the athlete must be conditioned to both physically and mentally experiencing running fast through their entire athletic career. Speed must never be neglected at any stage of development, whether it be in the cold of winter, the precompetitive season in the spring, or the peak of summer. Speed must be sustained from week to week, month to month, and year to year. The skill of running fast is a learned response and, in order to be developed, it must be included in the regimen of the athlete. The more athletes run fast as a part of their development, the more they expect to run fast and, as a consequence of expecting to run fast, they do.

The practice of running fast becomes natural and does not represent an artificial obstacle. When an athlete runs long and slow, he/she will inevitably feel

that the pace is plodding and has been lost. Consequently, courage and confidence are lost in a race. Running fast, even though moderate intensity sessions are practiced, makes an athlete feel confident and inspired to run fast in races. The belief of running fast becomes ingrained.

The physiologic importance of aerobic, aerobic/anaerobic, and anaerobic development is clearly defined in chapter five. I would like to suggest that you understand these energy system components well. Table 5.2 shows the percent of energy that comes from aerobic and anaerobic energy for both the 800 and 1,500 meter runs. Compare it to the following table.

	Aerobic	Anaerobic
3,000 meters	75%	25%
5,000 meters	80%	20%

TABLE 6.1 The percent of aerobic and anaerobic energies required to run the 3,000 meter and 5,000 meter runs.

Although the emphasis on the aerobic and anaerobic energy systems changes from time to time, of critical importance are the workouts that link these two systems.

In all middle distance and distance events, the distribution of time spent in designing aerobic or anaerobic workouts, or a combination of both, becomes like linking jigsaw puzzle pieces together. Although the emphasis on these energy systems changes from time to time, of critical importance are the workouts that link these two systems.

I recommend that flat 3,000 meter, 3,000 meter steeplechase and 5,000 meter runners work the same type of workouts with only two differences. One is the implementation of work to provide for individual variability. The other is to have steeplechasers work on the technique of steeple chasing. The following is a detailed description of the types of workouts I recommend.

I. Aerobic

A. Long Runs

1. Long runs should be run at least once in every microcycle during the base period and at least once every fourteen days during the precompetitive and competitive periods.

2. The long run permits the athlete to engage in active rest and also allows the body to recover from intensive workouts that he/she has undertaken.

3. Of great importance is the psychological benefit derived when the athlete realizes that he/she can overcome long, slow distances continuously. Athletes also develop self confidence in their ability to sustain activity over an extended period of time.

4. The distance that I recommend is 8 to 12 miles for young athletes, increased to 15 to 18 miles for mature and experienced runners. The distance, of course, will vary according to the athlete's development and maturity.

B. Intermediate Runs

1. These runs are seen as the basis of cardiorespiratory development and conditioning. They are run at 70% of maximum effort and increase to 85% of maximum effort.

2. The distance for 3,000 meter runners (specialists) is five times the race distance or 15 kilometers (9.4 miles) and for the 5,000 meter runners the distance is four times the race distance or 20 kilometers (12.4 miles).

3. The beginning intensity is 70% of the athlete's personal best time for that event (reference point) multiplied by five. This increases over time to 85% of personal best. To reach this level may take a period of three to four years.

4. Tables 6.2 and 6.3 display the prescribed recommendations for both 3,000 and 5,000 meter runners.

Levels Reference Point Goal for 3,000	*Local* 75% Effort 15 k 3k x 5=9.4 mi.		*Collegiate* 75% Effort 15 k 3k x 5=9.4 mi.		*National* 80% Effort 15 k 3k x 5=9.4 mi.		*International* 85% Effort 15 k 3k x 5=9.4 mi.	
7:00	10:00	50:00	9:20	46:33	8:45	43:45	8:14	41:12
8:00	11:26	57:09	10:40	53:21	10:00	50:00	9:25	47:03
9:00	12:52	1:04:00	12:00	60:00	11:15	56:15	10:35	52:57
10:00	14:17	1:11:00	13:20	1:07:00	12:30	1:03:00	11:46	58:48
11:00	15:43	1:19:00	14:40	1:13:00	13:45	1:09:00	12:56	1:05:00
12:00	17:08	1:26:00	16:00	1:20:00	15:00	1:15:00	14:07	1:11:00
13:00	18:34	1:33:00	17:20	1:27:00	16:15	1:21:00	15:17	1:16:00

TABLE 6.2 3,000 meter training, five-times the race distance. The intermediate runs (distance and intensity) to be achieved either once per microcycle or every 14 days, depending on the training phase.

C. Short, Fast Runs

1. These runs are usually referred to as anaerobic threshold (A.T.) runs. These infrequent runs are run at a heart rate of 168 to 172 heart beats per minute and this intensity is at about the 4mM/L level. The objective is for the younger athletes to run for twenty minutes, about four miles.

   The older athletes attempt A.T. runs of six, eight, and ten miles, depending on the athlete's experience and fitness levels. Every attempt is made to run a short, fast run once in every seven-day microcycle. The longer distances (for the more experienced athlete) are once every two microcycles during the base phase of training.

2. Because 3,000-meter runners often attempt an overdistance 5,000 meter race, it is recommended that these athletes follow the same plan.

However, during the competition phase when they are specializing in the flat 3,000 meters or the steeplechase, the shorter twenty-minute A.T. run is recommended.

Levels	*Local*		*Collegiate*		*National*		*International*	
Reference Point Goal for 5,000	75% Effort 15 k 5k x 4=12.4 mi.		75% Effort 15 k 5k x 4=12.4 mi.		80% Effort 15 k 5k x 4=12.4 mi.		85% Effort 15 k 5k x 4=12.4 mi	
13:00	18:30	1:14:00	17:20	1:09:00	16:15	1:05:00	15:17	1:01:00
14:00	20:00	1:20:00	18:40	1:14:00	17:30	1:10:00	16:28	1:05:00
15:00	21:26	1:26:00	20:00	1:20:00	18:45	1:15:00	17:39	1:10:00
16:00	22:52	1:31:00	21:20	1:25:00	20:00	1:15:00	18:49	1:15:00
17:00	24:17	1:37:00	22:40	1:30:00	21:15	1:25:00	20:00	1:20:00
18:00	25:43	1:42:00	24:00	1:36:00	22:30	1:30:00	21:11	1:25:00
19:00	27:08	1:48:00	25:20	1:41:00	23:45	1:35:00	22:21	1:29:00
20:00	28:34	1:54:00	26:40	1:47:00	25:00	1:40:00	23:34	1:34:00

TABLE 6.3 5,000 meter training, four-times the race distance. The intermediate runs (distance and intensity) to be achieved either once per microcycle or every 14 days, depending on the training phase.

D. Fartlek Runs

1. The long runs, the intermediate runs, and the short, fast runs are linked together by two variations of the Fartlek method. The first type of Fartlek involves the traditional undulating efforts involved in a play of speed, but the major effort rarely exceeds a steady state intensity (never beyond 80% effort).

2. The second variation of the Fartlek involves intermittent running with the athlete inserting surges of one, two, and three minutes, involving distances of 400 to 1,000 meters. These surges are very fast and athletes accelerate into them. The rest of the Fartlek run can be easy or, at least, in a steady state mode.

3. Other types of running are introduced during the aerobic phase such as out–and–back runs where the return, or latter half of the run, is run with a negative split. The important objective during the base phase is that the athlete have fun and that a minimum of psychological stress be exerted to complete the workouts.

E. Stepping Stone Runs

1. An athlete can employ one of two different stepping stone sessions which involve distances of six to twelve miles while running each mile at a predetermined speed. The first stepping stone effort involves running a twelve mile run with alternating speeds of 6:00, 5:30, and 5:00 per mile and repeating it four times, or alternating two speeds of 6:00 and 5:00 per mile and repeating it five or six times.

The objective in the stepping stone sessions is to encompass all elements of aerobic development and to adapt to physiological stresses encountered in this theme.

2. The second method of stepping stone sessions is to determine the velocity at VO_2 max for an individual athlete, then backtrack ten to fifteen seconds per mile for the distance the athlete would like to achieve.

   Example:

   A runner has vVO_2 max of 4:35 and wishes to run ten miles. The workout session would start with a 6:50 mile and terminate with a 4:35 mile on the tenth mile. (Example of mile times descending 6:50, 6:35, 6:20, 6:05, 5:50, 5:35, 5:20, 5:05, 4:50, 4:35.) Employing a ten second increase in intensity would result in the mile times beginning with a 6:05 mile and terminating with a 4:35 mile. (Example of mile times descending 6:05, 5:55, 5:45, 5:35, 5:25, 5:15, 5:05, 4:55, 4:45, 4:35.)

3. The objective in the stepping stone sessions is to encompass all elements of aerobic development and to provide the athlete with the opportunity to adapt to the physiological stresses encountered in the development of this theme.

4. The types of runs included in aerobic phase of 3,000 and 5,000 meter training are as follow:

    a. The long run.
    b. The intermediate run.
    c. The short, fast run.
    d. The traditional Fartlek.
    e. The advanced Fartlek with greater intensities.
    f. The stepping stone sessions with alternating speeds.
    g. The stepping stone sessions with increasing mile speeds, terminating with vVO_2 max speed.

In February of 1983 I attended a coaching seminar in Lisbon, Portugal and heard John Anderson, then Scottish national athletics coach, present his views on the transition from aerobic to anaerobic training. Until that time the number of athletes who would get injured at this transitional point in their training was legendary. Ten years have passed since then, and I have religiously implemented that valuable bit of information into my training programs very successfully, with the result of having few injuries to my athletes. It has become clear that we must view a training program as a balance with the *aerobic phase*, the *fulcrum*, and the *anaerobic phase*.

The fulcrum provides the link or bridge between the aerobic and anaerobic phases. In practice it involves extended runs at a faster pace with reasonable recoveries. The two sessions principally used in this are:

a. 6 x 1 mile repeats with a three-minute recovery.

b. Repeat 800's or 1,000's with a three to five-minute recovery depending on the running speed. The faster the run, the longer the recovery.

It seems logical that the speed build up during the aerobic phase should be sustained as much as possible as one goes into the cross country season, which is a large part of the aerobic build up. It becomes clear that all three elements in the training program should be incorporated throughout the year in the development of the athlete. The content of the program remains the same year in and year out, but the emphasis changes from season to season. Those aspects of the training which are emphasized at any given point in the season will depend on the adaptation and development of the athlete.

The training sessions I have developed have been implemented in similar fashion with only one dimension changing. This is the speed of the workout in which the 6 x 1 mile repeats are run. The athletes I have worked with feel that this workout does more to improve the strength and the speed of distance runners than any other workout. The recoveries remain constant but the average speed of the repeat miles increases progressively. (See Table 6.4.) The reference point for the mile at Level I is 4:00 minutes. During the base phase, the athlete adapts to running 6 x 1 mile repeats at 80% intensity which gives him a time of 5:00 minutes for each mile with a three-minute rest interval.

When the pre-competition season begins, the athlete runs the repeat miles at 85% intensity, where the speed of each mile is 4:42. The intensity remains at this level until the athlete has adapted to it completely. It may take three weeks or three months, depending upon the individual's fitness. The speed increases in two to three-percent increments until the speed reaches close to the 94% range at the end of the peaking period for the important championship or key event of the season. At this time the athlete will be running the 6 x 1 repeat miles at a speed of 4:15 per mile with a three-minute recovery interval, a profound increase in speed. The objective is to maintain this training philosophy for as long as the athlete continues to train for competitive purposes. As you can see, repeat miles are run throughout the training year. The basic difference is the intensity.

A test of adaptation is determined by the athlete's ability to run the same intensity for a two-mile distance. These times are also found in Table 6.4. When the athlete can do this comfortably, he/she is then ready to move on to the next percent which will produce a higher intensity. In the world record run by Gebreselasie, the average mile speed was 4:08 per mile for 12:24 three-mile time, plus thirty-one seconds for the last 200 meters, with a total 5,000-meter time of 12:56.96. According to this concept, Gebresilasie has the capacity to run 4 – 6 x 1 mile in 4:08 - 4:10 speed. A test of adaptation at this intensity would be to run the two mile distance in 8:16 – 8:20 in practice, which he has often done during the competitive track season.

Over the years there have been slight modifications in my program, but an attempt has been made to stick to the essential training principle of increasing speed. Most of the year I try to maintain a seven-day microcycle, but there are periods when I have used ten, fourteen, and twenty-day microcycles. This has allowed for the opportunity to implement all of the training ingredients proposed.

Although it is true that distance runners cannot achieve success without a relative high VO_2 max, it is also clear that high anaerobic reserves play a significant part in prolonged aerobic running. The evidence has clearly shown that anaerobic running will result in the breakdown of glycogen into lactic acid. It has also been shown that lactic acid accumulates much more slowly when short periods of exercise are followed by short rest periods, thus permitting more work to be accomplished. The running research has clearly indicated that the performance of short sprints not only develops the anaerobic mechanism but increases the tolerance to lactic acid and other waste products. These two changes will allow for more varied adaptation of the body and will increase the potential for both aerobic and anaerobic work. It has also been shown that running short distances at speeds faster than normal will produce increased capacity for the supply of oxygen, simultaneously involving higher levels of energy exchange prior to lactic acid developing. It appears that, running at maximum effort, athletes will find an ability to supply more oxygen and incur higher oxygen debt as a consequence of these speed training programs.

II. Anaerobic

During this training phase the emphasis is on the development of basic speed and extended speed endurance. To achieve this objective, a number of different workouts are emphasized.

A. As described in the previous chapter and again in this chapter in the section of link or fulcrum, it is the intended objective to run distances of at least one kilometer, one mile, or two kilometers at $vV0_2$ max. If the athlete works at 90% of this intensity, he/she is recruiting fast twitch fibers. The closer to 100% vVO_2 max, the greater number of fibers recruited.

B. Maximum effort running, requires the athlete to run distances of sixty meters to 600 meters in all-out flat speed. After each repetition, full recovery is allowed.

C. Short repetition runs of 60 meters to 100 meters run back–to–back are as follows:

   3 x 3 x 60 or 100 meters with thirty seconds recovery between the repetitions and diminishing recoveries of two minutes, one minute and thirty seconds, and one minute between the sets. All of the repetitions are run at between 95% and 100% maximum effort.

Reference Point Training = Mile Time

Level	*Repeat Mile Times*		*Max VO_2 2-Mile Times*
Level I	85%	4:42 -5:00	9:24 - 10:00
4:00 - 4:15	88%	4:32 - 4:50	9:02 - 9:40
	91%	4:24 - 4:40	8:48 - 9:20
	94%	4:15 - 4:31	8:30 - 9:02
Level II	85%	5:00 - 5:17	10:00 - 10:34
4:15 - 4:30	88%	4:50 - 5:07	9:40 - 10:14
	91%	4:40 - 5:00	9:20 - 10:00
	94%	4:31 - 4:47	9:02 - 9:34
Level III	85%	5:17 - 5:35	10:34 - 11:10
4:30 - 4:45	88%	5:07 - 5:13	9:54 - 10:26
	91%	4:57 - 5:13	9:54 - 10:26
	94%	4:47 - 5:03	9:34 - 10:06
Level IV	85%	5:35 - 5:53	11:10 - 11:46
4:45 - 5:00	88%	5:24 - 5:41	10:48 - 11:22
	91%	5:13 - 5:30	10:26 - 11:00
	94%	5:00 - 5:16	10:00 - 10:32
Level V	85%	5:53 - 6:10	11:46 - 12:20
5:00 - 5:15	88%	5:41 - 5:58	11:22 - 11:56
	91%	5:30 - 5:46	11:00 - 11:32
	94%	5:16 - 5:31	10:32 - 11:02
Level VI	85%	6:10 - 6:28	12:20 - 12:56
5:15 - 5:30	88%	5:58 - 6:15	11:56 - 12:30
	91%	5:46 - 6:02	11:32 - 11:42
	94%	5:31 - 5:51	11:02 - 11:42
Level VII	85%	6:28 - 6:45	12:56 - 13:30
5:30 - 5:45	88%	6:15 - 6:32	12:30 - 13:04
	91%	6:02 - 6:19	12:04 - 12:38
	94%	5:51 - 6:07	11:42 - 12:14
Level VIII	85%	6:45 - 7:03	13:30 - 14:06
5:45 - 6:00	88%	6:32 - 6:49	13:04 - 13:38
	91%	6:19 - 6:35	12:38 - 13:10
	94%	6:07 - 6:22	12:14 - 12:44

TABLE 6.4 The training intensities for 6 x 1-mile workouts. The level of progression is 3% each time there is an increase.

Max Speed Level	Max Speed for 1 mile	Race Pace for 400m	400 Training Ratio			
			5,000	1:1	1:1.5	1:2
			92% ± 1	10 - 12	14 - 16	18 - 20
1	3:50 - 100%	48 - 100%	13:00 ± 1	58 - 60	62 - 64	64 - 66
			4:10			
2	4:00 - 100%	50 - 100%	13:30 ± 15	60 - 62	64 - 66	66 - 68
			4:20			
3	4:10 - 100%	52 - 100%	14:00 ± 15	62 - 64	66 - 68	68 - 70
			4:30			
4	4:20 - 100%	54 - 100%	14:30 ± 15	64 - 66	68 - 70	70 - 72
			4:40			
5	4:30 - 100%	56 - 100%	15:00 ± 15	66 - 68	70 - 72	72 - 74
			4:50			
6	4:40 - 100%	58 - 100%	15:30 ± 15	68 - 70	72 - 74	74 - 76
			5:00			
7	4:50 - 100%	60 - 100%	16:00 ± 15	70 -72	74 - 76	76 - 78
			5:10			
8	5:00 - 100%	62 - 100%	16:30 ± 15	72 - 74	76 - 78	78 - 80
			5:20			
9	5:10 - 100%	64 - 100%	17:00 ± 15	74 - 76	78 - 80	80 - 82
			5:30			
10	5:20 - 100%	66 - 100%	17:30 ± 15	76 - 78	80 - 82	82 - 84
			5:40			
	A	***B***	***C***	***D***	***E***	***F***

0 -	Elite Athletes Levels	1 & 2	0 +	Elite Athletes Levels	5 & 6
	National Levels	3 & 4		National Levels	7 & 8
	High School Levels	5 & 6		High School Levels	8 & 9
	Beginners Levels	7, 8 & 9		Beginners Level	10

All aerobic workouts taken from 10,000 meter training schedule

During the competitive season:

1 day miles	-	Never more than five (5)
1 day 400's	-	Greater number early in season - faster towards peaking
1 day speed	-	Individual variability

TABLE 6.5 Relationship between volume and intensity for 400 meter training, based on max speed for 1 mile anticipated race pace for 5,000 and max speed for 400.

D. Acceleration workouts, which were described in Tables 5.15 and 5.16 of the previous chapter on 800/1,500 meter training, are also of prime importance in 3,000 - 5,000 meter training. These acceleration workouts must be included during most of the competitive season in order to peak for the top events of the year.

E. Refer to Table 5.12, 5.13 and 5.14 where reference is made to all-out 400 meter runs. These are also extremely valuable and must be incorporated in 3,000/5,000 meter training.

F. It is recommended that, during the competition season, repeat 400s be run on the track as prescribed in Table 6.5. Keep in mind the progression from 1:2 work to rest ratio, to 1:1.5, and then a 1:1 as you get to the end of the season. The athlete would also work at the level prescribed by either his/her max speed for the 1 mile distance, or the max speed for the 400 meter.

3,000 Meter Steeplechase Training

The steeplechase requires that the aerobic component to be developed be positioned between 1,500 and the 5,000 meters. It is better to have it closer to the 5,000 meter. The anaerobic component will be closer to the 1500 requirements by nature of the distance of the race. The muscular strength required to execute all 35 jumps (28 barrier and 7 water jumps) is of extreme importance, and I feel that steeplechasers must have additional strength and power work incorporated into their ancillary workouts. As athletes progress through the race, some athletes will not have the strength to generate the muscular tension to execute the jumps. They are demonstrating why additional strength and power work is necessary.

Although there are no rules regarding the clearing of these hurdles, the most time and energy conserving method is to hurdle them (rather than jumping them). There are very successful steeplers who have good form over the barriers. There are also athletes who have great stamina and speed and their strength lies in covering the 78 meters between barriers. By refining their hurdling technique, they will most assuredly have much faster times.

It is essential that the athlete spend a considerable amount of time in developing hurdle technique. However, no amount of barrier clearance technique will compensate for good middle distance training. Steeplers must develop the

speed of a miler with the endurance of a great 5,000 meter runner. Keep in mind that the time differences between a flat 3,000 and a 3,000 meter steeplechase is between 35 seconds for an excellent steepler to 45 seconds for the novice.

Steeplechase training requires you consider that the amount of fatigue encountered in clearing barriers causes a disruption of the running rhythm. Consequently, barrier practice will be limited to once a week. Athletes can run over intermediate hurdles on the track as secondary workouts early in the season.

Another consideration is to develop the best flexibility possible in the ankle, hip, and shoulder region while also developing excellent leg and abdominal strength. At least once a week, athletes should concentrate on barrier work, and most of it should be on the grass infield. Concentrate on the following points:

I. Barrier Technique (Refer to Figure 6.1)

A. Perform hurdling drills before barrier work, concentrating on trail leg exercises. The emphasis is always on pulling the trail leg through strongly. The lead leg exercise should be practiced with alternate legs and the emphasis should be on putting the lead leg down as quickly as possible after barrier clearance. The objective is to be airborne for a minimal amount of time.

B. Good forward lean into the hurdle prior to running over it.

C. Fast pickup of forward leg flexed and through a straight line.

D. The knee must be at its highest point before the foot swings in front of it.

E. Fast pull through of the trailing leg.

F. Push through of the opposite arm to the lead leg, keeping shoulders square to the front to eliminate lateral rotation of the trunk.

G. The heel of the trail foot should be tucked in toward the bottom and the knee should be brought up toward the armpit. It should then be brought across the hurdle and around the front of the body into a sprinting position.

H. Always charge the barrier so that you approach and go over it with authority. This, of course, requires a lengthening of the stride length as you approach the barriers.

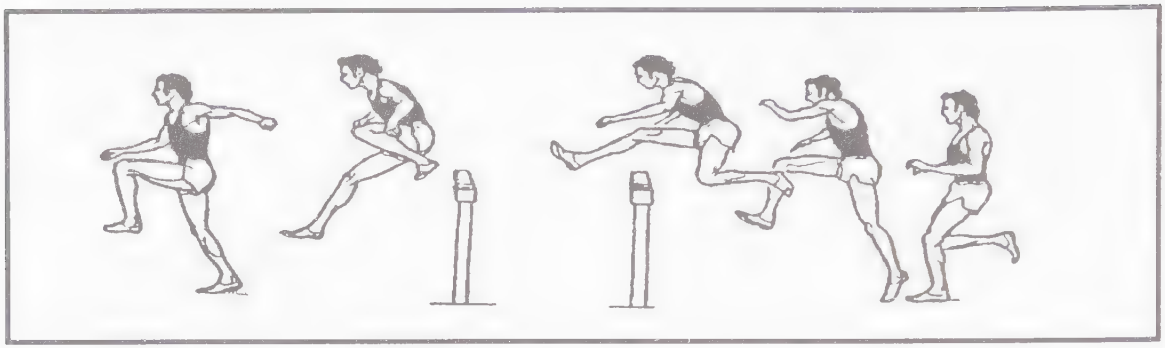


Figure 6.1 Steeplechase barrier clearance.

II. Water Jump Clearance (Refer to Figure 6.2)

A. Get in close before mounting the barrier.

B. Lean in, drive up and forward with a fast knee action.

C. Place foot firmly on the barrier.

D. Keep trunk low and hips moving forward fast.

E. Aim for a good split between the legs during and over the water jumps.

F. Try to obtain full extension of the rear leg by keeping foot in contact with the barrier as long as possible before the final push off.

G. As with the barrier work, it is necessary to keep the center of gravity as low as possible when moving over the water jump barrier.

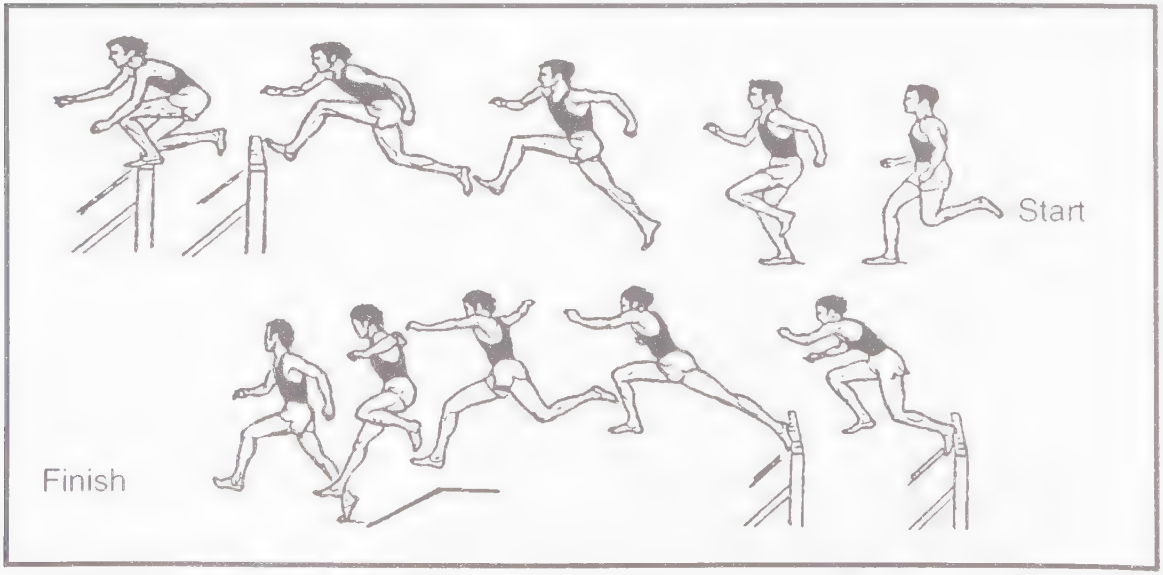


Figure 6.2 The water jump clearance technique.

As you train for the 3,000 meter steeplechase, remember that even pace running is always best. To help you establish a goal, refer to Table 6.6.

400 meter pace	3,000 flat time	3,000 steeple time
60	7:30.0	8:05.00
61	7:37.5	8:13.50
62	7:45.0	8:21.00
63	7:52.5	8:28.50
64	8:00.0	8:37.00
65	8:07.5	8:45.50
66	8:15.0	8:54.00
67	8:22.5	9:06.05
68	8:30.0	9:09.00
69	8:37.5	9:18.50
70	8:45.0	9:25.00
72	9:00.0	9:41.00
74	9:15.0	9:57.00
76	9:30.5	10:14.50
78	9:45.0	10:30.00
80	10:00.0	10:45.00

TABLE 6.6 Prescribed Speed - 400 for the desired 3,000 flat and 3,000 steeplechase times.

I have now discussed the characteristics of the 3,000 steeplechase and 5,000 meter events and the training methods athletes participate in. The following three microcycles are examples of what can be done as a workout during the basic phase, precompetitive phase, and competitive phase.

BASE MICROCYCLE

(70-100 miles per week - majority of distance on dirt or grass)

Sunday — Long run of 25-30 kilometers (15-19 miles) once every 14 days. On the alternate Sunday a shorter 20 kilometer (12.5 mile) run. Refer to table 6.2 and 6.3 for intensity of runs.

Monday — A recovery or restitution run which would allow the body to recover from the Sunday workout. Keep the heart rate down to 130-150 BPM.

Tuesday — A 4-5 mile workout in the a.m. to get the body going, then an 8-10 miler in the p.m. at a heart rate of 140-160 BPM.

Wednesday	A Fartlek run in which you would alternate the traditional play of speed but never exceed the steady state intensity or, at least, never begin with greater than an 80% effort. On the alternate workout, every other week, run light surges of one, two, and three minutes duration during the Fartlek run.
Thursday	Start incorporating your Fulcrum runs. You must be careful not to start with great intensity and do not exceed a greater speed than 85% of intensity, whether you are using the repeat miles or repeat 1K's.
Friday	Recovery run.
Saturday	Alternate a 20 minute anaerobic threshold run one week with a 6-8-10 mile on the next Saturday. If these base phase runs occur during the cross country season, a competition can serve as the workout.

PRECOMPETITIVE MICROCYCLE

Sunday	Continue doing long runs of no more than 20 kilometers or 12.4 miles.
Monday	A 400 meter workout during this time of the year work at 1:2 or 1:1.5 ratio. (Table 6.5)
Tuesday	Recovery run of 1 hour.
Wednesday	Recovery run of 1 hour finishing with 6–10 x 150 meter strides on the track.
Thursday	Repeat miles 800 or 1000's up to 85 or 90% all out effort just enough to stimulate fast twitch fiber recruitment.
Friday	Recovery run of 1 hour.
Saturday	Competition or an AT run of 4 miles (20 minutes) x 2.

To develop overall racing ability from 800-5,000 meter distance, I have used the 5 Tier program presented by Martin and Coe in their book on distance running. This program incorporates a five tier training program with a 15 day microcycle. I have athletes repeat it 3–4 times, depending on the length of the precompetitive phase.

5 TIER TRAINING PROGRAM

A	Repeat miles x 4	4:10	At 5,000 Pace
	Repeat 2ks x 3	5:12	Example: 13:00
	Repeat 1ks x 5	2:36	Recovery 3–5 minutes
B	Repeat 800's x 6-8	At 3,000 Pace Example: 7:30 2:00 with 400m easy jog recovery	
C	Repeat 400's x 5	At 90% – 95% velocity 50:00 – 400 55.5 – 52.6 secs. 48:00 – 400 53.3 – 50.5 secs. 5 – 7 minute interval	
D	Repeat 200's x 16–30	At 1,500 speed Example: 4:00 mile 30 secs/200	
E	Speed workout – all–out (48:0 400 meter run)	1 – 300 2 – 200 4 – 100 8 – 60	34–36s 5 min. interval 22–24s 200 jog all–out 3–5 min. interval all–out 3–5 min. interval

5 TIER TRAINING PROGRAM INCORPORATED INTO 14 DAY MICROCYCLE

Day	**1**	12 – 20 miles AM or PM		
	2	AM – 7-8 miles	PM	– rest
	3	A: (Repeat miles 2ks or lks)		
	4	AM – 4 miles	PM	–10miles with surges
	5	AM – 15 miles	PM	– rest
	6	B: (Repeat 800's)		
	7	AM – 9 miles	PM	– rest
	8	12 - 17 miles AM or PM		
	9	C: (Repeat 400's)		
	10	AM – 5 miles	PM	– rest
	11	D: (repeat 200's)		
	12	AM – 5 miles	PM	– 5-7 miles
	13	E: (speed workout)		
	14	Easy 5 miles with 6–8 strides		
	15	Time trial or meet		

With the completion of the precompetitive phase workouts, the competition phase presents the challenge of fine tuning the athlete for the important competitions of the year. By now we have been able to determine the strengths and weaknesses of our athletes. We can continue to work toward our goals, but specific work on the athletes' speed components continues at the same time that they maintain the strong aerobic base developed during the base microcycle.

COMPETITION MICROCYCLE

Sunday	Continue to do a long run of no more than 20KMS (12.4 miles). Run according to your inclination on how you feel and how you handled the week just finished.
Monday	Recovery run of 1 hour.
Tuesday	Alternate workouts every other Tuesday. One week run 60–600 meter distances in all out flat speed, with full recovery. The next Tuesday run 4 x 400 as close to all–out speed as possible with a 5–8 minute recovery between them.
Wednesday	Recovery run of 1 hour.
Thursday	Run repeat 4 x 1 mile at vVO_2 max from Table 6.4. This involves very fast running, so concentrate on running at least at the 94% level of ability during the microcycle.
Friday	Recovery run of 1 hour and 6–10 all out strides of 75–100 meters.
Saturday	Competition or an anaerobic threshold run of 20 minutes.

3,000/5,000 Racing Tactics

The racing distance of the 5,000 meters is 6.25 longer than the 800 and 3.3 times longer that the 1,500. The 3,000 flat and steeple are 3.75 times longer than the 800 and twice as long as the 1,500 meter distance. I mention this only to remind the athlete that both races are run at a pace near or at 100% VO_2 max. It is, therefore, of the utmost importance, that during your training, you raise your VO_2 max as high as possible.

All middle and long distance runners need to understand the dietary considerations involved in these events. The 5,000/3,000 use carbohydrates as the predominant energy source. On the days leading to important races, the cellular carbohydrate concentration should be as high as possible.

The following points should be discussed between the coach and athlete and understood clearly in order to insure success in the race.

1. A lactate accumulation will begin to occur early because the pace will be faster than the lactate/ventilation threshold pace.

2. Blood lactate levels will soar while sprinting toward the finish, therefore the current starting point of attack on the finish is important.

3. The most economical strategy is to run as even paced as possible to keep acidosis at the lowest possible level.

4. It is imperative to learn good pace judgement and rate of perceived exertion at race pace. The athlete must understand the sensation of effort involved at all paces encountered during a race.

5. It is unlikely to expect the athlete to run the 3,000 or 5,000 meters in an economic manner. In every race there are a mixture of runners – strong finishers – mid race surgers – strong pace runners throughout – strong starters.

6. Study your competition. Both the strengths and weaknesses of all athletes you compete against must be understood.

7. As you and your coach devise the strategy you will employ, make sure that the objective to reach your goal is understood. Will you run to win, to place, or go for a record? In establishing these goals, make sure you optimize your best pace in light of your strengths.

EARLY RACE STRATEGY

It is important not to run too fast too early. The agony of acidosis promotes the inhibition of muscle tension and leads to rapid discomfort. These conditions bring accessory organs into play in an effort to keep pace. This will affect running economy

profoundly and increase oxygen consumption. The following recommendations should be considered in order to allow the athlete to run an optimal race.

1. After the first few laps, you must resist the trend to begin pushing the pace or take the lead because the pace seems slow. Save the fastest lap for last and remember how many laps you have run and how many laps remain. The runners in front will use more energy, both in leading the race and fighting the wind. Remember to "run in the aerodynamic shadow of the opponent."

2. Calculate an even pace per lap that best estimates your current potential.

3. As you get into the race, the positive feeling of passing people boosts your confidence.

4. Most great 3,000/5,000 meter runners have a lactate threshold close to their already accumulating high VO_2 max. This one variable keeps lactates low, even at paces of 63-65 seconds/lap. The energy costs can be enormously high.

STRATEGY FOR THE FINISH

Whatever your goal, the last 3-4 laps of the race must be a relentless sustained drive. Whatever the distance, be ready for the increase in pace that comes along with this strategy. Keep the following in mind:

1. The last 1, 2, 3 or 4 laps must be faster than the race pace you have established for yourself.

2. To be successful in your race, you must be committed, without doubt, to endure pain longer than your competitive adversary.

3. Work on speed all year long and remember -
   to run fast, you must train fast.

4. It is always advisable to run distances over and under your preferred racing distance.

Study Guide

1. Why is it important to run fast throughout the year?

2. What percent of aerobic and anaerobic energy is required for both the 3,000-5,000 meter distances?

3. What are the 5 types of workouts the athlete incorporates in base or aerobic development?

4. What is the concept of the fulcrum, or the link, and the importance in the year around training program?

5. Know how to incorporate the development of base speed by implementation of the various types of anaerobic development.

6. Know how to work in steeplechase technique workouts in the overall weekly microcycle.

7. What speeds are necessary per 400m to achieve realistic goals?

8. Understand the philosophy behind the 5 tier training program.

9. Develop a sound racing tactic for each race.

10. What precompetitive and competitive workouts are beneficial to the training of athletes?

Dan Maas leading the pack in the 5,000.

Demonstration of good barrier form as Jason Mohr is on his way to a National Championship in the 3,000 meter steeplechase.

7 10,000 Meter Training

" The most powerful weapon on earth is the human soul on fire"

- Ferdinand Foch

Overview

This chapter will discuss a detailed plan of training for 10,000 meter distance runners. It includes a short history of distance running, energy systems used throughout the race, several detailed training programs, peaking tendencies and racing tactics.

Introduction

Prior to the World Championships in Stuttgart, Germany in August of 1993, the world all–time list revealed that there were only two Americans in the top 25 of the 10,000 meters. Mark Nenow posted a 27:20.56 in Brussels on the 5th of September, 1986, and, prior to that, Alberto Salazar ran 27:25.61 in Oslo on the 26th of July, 1982. These times earned them an 11th and 21st position on the all–time list.

I have served as a Collegiate, National, an International Coach and Clinician, have served on staffs of the Jr. and Sr. Elite distance camps at the USOTC in Colorado Springs and have observed the evolution of the American distance runners for nearly three decades. I believe that we have the talent pool in our great country to have 2-3 athletes in the top 10 list in the world for the 10,000 meters.

This chapter is intended to help distance runners with a detailed plan of training, adjusted to cover various performance categories, with the end result being an outstanding 10,000. My contribution is not meant to proclaim dogmatic principles but only to provide realistic guidelines. Considering the great number of third world country athletes who are running 10,000 meter races for the first time and exceeding our national record, we have to take a realistic view of many things. Among these is our basic philosophy of training, life and competition. When we do

this, we see the great difference that exists between those who are successful in this event and those who are not. In order to succeed, we must train in areas where we can focus totally, have coaching that will challenge every aspect of our being and develop a mental toughness that will allow us to reach our goals.

The following principles have been well documented by research and are extremely important in developing a rational training program. Table 7.1 shows clearly the contribution of aerobic and anaerobic energy usually required in the 10,000 meter run. The following principles demonstrate the metabolic processes that interact:

I. The longer the distance, the more the athlete is dependent on aerobic energy (Table 7.1).

   A. The higher the ratio of slow twitch fibers (STF) to fast twitch fibers (FTF), the easier it is for a runner to adapt to distance running.

   B. The enzymatic activity found in STF allows the runner to produce aerobic energy. The higher the maximum oxygen uptake (VO_2 max), the greater the amount of aerobic energy produced.

   C. The ratio of STF to FTF is a genetic factor and, for all practical purposes, cannot be changed. However, changes can occur in the biochemical characteristics of each fiber to make them more efficient.

   D. It has been observed that FTF can acquire the characteristics of STF after a prolonged base of high volume training.

II. The aerobic endurance component does not depend as much on oxygen transport to working muscles as on the capacity of the muscle cells to utilize the available oxygen. Oxygen utilization is determined by the following processes:

   A. The density of the capillary network.
   B. The hemoglobin level in the blood.
   C. The quantity of mitochondria in the cells.
   D. The activity of the enzymes in the mitochondria.

   All of the above processes allow for the development of a high oxidative potential and they occur in STF.

Energy Sources

	Aerobic	Anaerobic
10,000 meters	90%	10%

TABLE 7.1 The percent of Aerobic and anaerobic energy requirements for the 10,000 meter run.

III. Simultaneous to the aerobic activity, favorable conditions are being created to utilize lactate formed in FTF. This allows the following:

A. The development of a more economic aerobic process.

B. The ability to preserve the limited supplies of glycogen and phosphogens for the latter stages of a race. It is during this period that an effective finishing kick in distance running is required.

IV. The hypoxic condition doesn't increase with increased power output. But, the greatest stimulus for the production of chemical changes in muscle fibers is the production of power which utilizes 100% VO2 max. Work loads of 2–5 minutes and a rest period of the same length (1:1 ratio) are the most effective to produce aerobic power.

A. As previously mentioned, work loads of 90% VO_2 max initiates the recruitment of FTF.

B. The recoveries between bouts of exercise prevents excessive accumulation of lactic acid and allows runners to increase the training beyond 30 minutes.

C. Without these workouts and recovery periods, the workouts would be limited to 10–12 minutes.

D. The cardiac minute output (CMO) is also very important and is crucial in the role of oxygen transport.

E. One should monitor workloads and be careful not to do more work than the body can adapt to or tolerate.

V. The body can more easily adapt to running by using the following training methodologies:

A. A progressively increased training load.

B. Variation to the intensity.

C. The maintenance of all aspects of training throughout all periods, changing only the work/rest ratio and the volumes.

The 10,000 meter run is defined as a critical speed event in which the athlete competes at, or close to, his/her velocity at maximum oxygen consumption (vVO_2 max). All energy distribution charts have shown that the 10,000 is 90% aerobic. Therefore, athletes who run this distance have a fiber distribution dominated by STF.

In today's running, the long distance runner has been attracted to road running, and track specialists put their emphasis on the 3,000 or 5,000 distances. It is only in Europe, specifically the Scandinavian and northern European countries, that the 10,000 receives the recognition this classic event deserves. It is of particular interest that the training methodologies for the 10,000 appear to be somewhat similar to the 5,000. The double victories in both the 5,000 and 10,000, by Viren in 1972 and 1976, as well as Yifter's victories in 1980, suggest that the 10,000 is simply an appendage of the 5,000.

The training for both of these events is very similar. The 10,000 meter runner can cover the first 8,000 meters aerobically and the last 5 laps can decide the outcome of the race. It has also been noted that the last 400 in the 10,000 has been run in 53-54 seconds and can sometimes be faster than the last 400 of the 5,000, the 1,500, and even some first class 800 meter races. Training should provide for the distance runner to switch to middle distance speed.

In his article on training the 10,000 meter runner, Manfred Steffny provides charts on training during base, track build up, and pre–peak periods. I have modified these charts into what I believe can be more realistically achieved in a training program.

Tables 7.2, 7.3, 7.4 and 7.5 offer complete training programs for close to one calendar year. In table 7.2, I offer three different types of endurance runs (ER) which are described as follows:

1. Slow endurance run (**SER**)
   an effort with a heart ratio of 135–150 BPM – very slow
2. Medium endurance run (**MER**)
   an effort with a heart ratio of 145–160 BPM – medium speed
3. Fast endurance run (**FER**)
   an effort with a heart ratio of 160–180 BPM, sometimes 190 BPM – a hard effort at fast speed.

The 30 km test (18.6 miles) is provided in table 7.3. This chart can be used in two different ways. First, athletes can adapt to local, collegiate, national, or international level at one level per year. Secondly, as their training starts for a new year, they can achieve a level every month or two as the their ability level allows. After the athlete's best reference point has been selected, all three 10km distances are run together without any break.

		D	E	F
Max Speed for 1 mile		80% of max speed for 1 mile Hard tempo (FER) continuous run 20 minutes - 1 hour	75% of max speed for 1 mile 1 hour run (MER) Aerobic	70% of max speed for 1 mile 1.5 - 2 hour run (SER) Steady State
Level		Pace Per Mile	Pace Per Mile	Pace Per Mile
1	4:00	5:00	5:20	5:40
2	4:10	5:10	5:30	5:55
3	4:20	5:25	5:45	6:10
4	4:30	5:35	6:00	6:25
5	4:40	5:50	6:10	6:35
6	4:50	6:00	6:25	6:50
7	5:00	6:15	6:35	7:05
8	5:10	6:25	6:50	7:20
9	5:20	6:40	7:05	7:35
10	5:30	6:50	7:15	7:45
11	5:40	7:00	7:30	8:00

FER = Fast Endurance Runs **MER** = Medium Endurance Runs **SER** = Slow Endurance Runs

Altitude Adjustment - 10 seconds per mile

Level	D *160 - 180 HR*	E *150 - 160 HR*	F *130 - 150 HR*
Elite	10 - 12 miles	These runs can be	This SER run should
National	8 - 10 miles	used as training runs	be practiced one or
Local	6 - 8 miles	and correlate to a	two times per week.
Begin. Collegiate	4 - 6 miles	MER. These should	Duration of the run is more
Begin. H.S.	2 - 4 miles	be practiced at least once per week.	important than the mileage.
	This effort should be practiced at least 2-3 times /week. Considered a FER.	Adhere to minutes per mile pace.	Adhere to minutes per mile pace.

TABLE 7.2 Intensity of aerobic development workouts for 10,000 meter training.

The 30km test run is the most adequate distance to test an athlete's 10,000 meter running ability. Allowances should always be made for weather conditions and terrain. Make sure that you allow for individual differences in the athletes. This plan is an excellent guide but can be modified as needed.

After visiting with hundreds of 10,000 meter runners the past 14 years at World Cross Championships and major International Competitions, the daily volumes I have listed in Table 7.4 are representative of the ability levels represented by these athletes. The Fartlek workout needs no explanation since it is a universally understood play of speed workout. The one heavy intensity workout of repetitions (10 x 1k or 6 x 1 mile) allows for a rest period of 3–5 minutes at near 1:1 work to rest ratio. The number of repetitions to be executed in hard training should be at least the same distance as the length of the race in which the athlete will compete. The one easy or recovery run should allow the athlete to recover fully. Since all athletes are different, each athlete should run according to his or her own inclination.

10,000 Meter Training - 3 Times Race Distance

Levels	*Local*		*Collegiate*		*National*		*International*	
Reference Point Goal For 10,000	70% Effort 30k 10kx3	18.6 mi	75% Effort 30k 10kx3	18.6 mi	80% Effort 30k 10kx3	18.6 mi	85% Effort 30k 10kx3	18.6 mi
27:00	39:00	1:57:00	36:00	1:48:00	34:00	1:42:00	32:00	1:36:00
28:00	40:00	2:00:00	37:00	1:51:00	35:00	1:45:00	33:00	1:39:00
29:00	41:00	2:03:00	39:00	1:57:00	36:00	1:48:00	34:00	1:42:00
30:00	43:00	2:06:00	40:00	2:00:00	38:00	1:54:00	35:00	1:45:00
31:00	44:00	2:12:00	41:00	2:03:00	39:00	1:57:00	36:00	1:48:00
32:00	46:00	2:18:00	43:00	2:09:00	40:00	2:00:00	38:00	1:54:00
33:00	47:00	2:21:00	44:00	2:12:00	41:00	2:03:00	39:00	1:57:00
34:00	49:00	2:27:00	45:00	2:15:00	43:00	2:09:00	40:00	2:00:00
35:00	50:00	2:30:00	47:00	2:21:00	44:00	2:12:00	41:00	2:03:00
36:00	51:00	2:33:00	48:00	2:24:00	45:00	2:15:00	42:00	2:06:00
37:00	53:00	2:39:00	49:00	2:27:00	46:00	2:18:00	44:00	2:12:00
38:00	54:00	2:42:00	51:00	2:33:00	48:00	2:12:00	45:00	2:15:00
39:00	56:00	2:48:00	52:00	2:36:00	49:00	2:27:00	46:00	2:18:00
40:00	57:00	2:51:00	53:00	2:39:00	50:00	2:30:00	47:00	2:21:00

Altitude Adjustment 4 – 5 seconds/1,000 meters

TABLE 7.3 10,000 Meter Training – 3 times race distance once every two weeks. Women run 2 times race distance at reference point goal.

Table 7.4 also demonstrates the inclusion of more track work than in the basic plan and an increasing intensity in the shorter distances. This provides for a uniform build up of training. Often athletes are in too much of a hurry to get on the track and, as a result, the maintenance or continuous development of the aerobic development suffers. This danger of one-sidedness in the development of intensity as compared to endurance is a fear that all coaches experience.

Target Time	28 mins	29 mins	30 mins	32 mins	34 mins
Monday a.m.	10km ER	10 km ER	10km ER	5km ER	5 km ER
p.m.	10 x 400-68	10 x 400-70	10 x 400—73	10 x 400-78	10 x 400-82
Tuesday	ER 3.40/km	ER 3:50/km	ER 4:00/km	ER 4:20/km	ER 4:40/km
Wednesday	8 x 1000 2:50	8 x 1000 2:55	8 x 1000 3:00	8 x 1000 3:10	8 x 1000 3:20
Thursday	ER 4:20/km	ER 4:30/km	ER 4:40/km	ER 4:50/km	ER 5:00/km
Friday	5000 m Test 14:30	5000 m Test 15:00	5000 m Test 15:30	5000 m Test 16:00	5000 m Test 16:30
Saturday	ER 4:20/km	ER 4:30/km	ER 4:40/km	ER 5:00/km	ER 5:20/km
Sunday	Fartleck 80 mins	Fartleck 80 mins	Fartleck 80 mins	Fartleck 80 mins	Fartleck 80 mins
Monday	20 km Light ER	15 km Light ER	15 km Light ER	10 km Light ER	10 km Light ER
Tuesday	5 x 2000 5:40	5 x 2000 5:50	5 x 2000 6:00	5 x 2000 6:20	4 x 2000 6:40
Wednesday	ER 3:40/km	ER 3:50/km	ER 4:00/km	ER 4:20/km	ER 4:40/km
Thursday a.m.	15 km ER	15 km ER	10 km ER	10 km ER	10 km ER
p.m.	10 x 300 42 seconds	10 x 300 44 seconds	10 x 300 46 seconds	10 x 300 50 seconds	10 x 300 54 seconds
Friday	15 km ER	15 km ER	12 km ER	12 km ER	12 km ER
Saturday	1 hr. easy	1 hr. easy	45 min. easy	45 min. easy	45min. easy
Sunday	> > > > > >	Lead-up races of 1,500 - 3,000 - 5,000 meters			< < < < < <

ER = Endurance Run

TABLE 7.4 Track build-up workouts – January, February, March.

Target Time		28 mins	29 mins	30 mins	32 mins	34 mins
Sunday		Acceleration	Acceleration	Acceleration	Acceleration	Acceleration
Monday		10 x 100 12 seconds	10 x 100 13 seconds	10 x 100 14 seconds	10 x 100 14 seconds	10 x 100 15 seconds
Tuesday	a.m. p.m.	30 min. ER 45 min. ER	30 min. ER 45 min. ER	30 min. ER 45 min. ER	30 min. ER 30 min. ER	30 min. ER 30 min. ER
Wednesday		1500 m TT 8 km jog	3000-5000 TT 8 km jog	3000-5000 TT 8 km jog	3000 TT 8 km jog	3000 TT 8 km jog
Thursday		60 min. ER	60 min. ER	60 min. ER	60 min. ER	60 min. ER
Friday		6 x 1200 m 3:15/km pace	6 x 1200 m 3:25/km pace	6 x 1200 m 3:35/km pace	6 x 1200 m 3:55/km pace	6 x 1200 m 4:15/km pace
Saturday		120 min. ER	120 min. ER	120 min. ER	90 min. ER	90 min. ER
Sunday		80 mins Fartleck 20 x 50 m spr.	80 mins Fartleck 20 x 50 m spr.	80 mins Fartleck 20 x 50 m spr.	80 mins Fartleck 15 x 50 m spr.	80 mins Fartleck 15 x 50 m spr.
Monday		3 x 3000 m 8:30 - 8:40	3 x 3000 m 8:40 - 8:50	5 x 2000 m 6:00	5 x 2000 m 6:20	5 x 2000 m 6:40
Tuesday	a.m. p.m.	60 min. ER 10 K accel. R	60 min. ER 10 K accel. R	60 min. ER 10 K accel. R	60 min. ER 8 K accel. R	60 min. ER 8 K accel. R
Wednesday	a.m. p.m.	45 min. ER 10 x 400 race pace - 2 seconds	45 min. ER 10 x 400 race pace - 2 seconds	45 min. ER 10 x 400 race pace - 2 seconds	45 min. ER 10 x 400 race pace - 2 seconds	45 min. ER 10 x 400 race pace - 2 seconds
Thursday	a.m. p.m.	60 min. ER 5 x 300 - 40-43 10 x 200 - 28-30 6 x 100 - all out	60 min. ER 41 - 44 29 - 31 all out	60 min. ER 42 - 45 30 - 32 all out	60 min. ER 46 - 48 32 - 35 all out	60 min. ER 48 - 50 34 - 37 all out
Friday		60 min. ER	60 min. ER	60 min. ER	60 min. ER	60 min. ER
Saturday		45 min. ER 6x150 m stride	45 min. ER 6x150 m stride	45 min. ER 6x150 m stride	45 min. ER 6x150 m stride	45 min. ER 6x150m stride
Sunday			> > > > > >	10,000 meter race	< < < < < <	

T T = track test accel. R = acceleration

TABLE 7.5 Track training – April, May June – before peaking.

All timed, short distances are done on the track. The repeat 1,000's and 2,000's can be done on the track or on the road. The ER (endurance runs) are all done on the road or on a grassed surface. Many top class runners are scared by the number of laps in the 10,000. This fright can be reduced by ER and some tempo runs off the track.

Table 7.5 illustrates workouts during the heavy track competition period. Acceleration runs are incorporated into the workouts. Sometimes referred to as crescendo runs, the objective is to increase the speed of each segment of the run.

Example: The athlete starts off at a slow pace with the last segment run the fastest. This can be over any distance the coach and athlete decide. The track workouts are more specific to the demands of the ability level of the athlete. In addition, the inclusion of speeds greater than vVo_2 are used. Two week micro-cycles are used in table 7.4 and 7.5 so that all the necessary workouts can be included, leading up to an excellent performance.

It is necessary for the coach and athlete to analyze the racing results after each race and, on the basis of their discussion, alter some of the workouts to include whatever they think is necessary. The workouts demonstrated in this chapter may not be an answer for everyone, but they have been used with great results by many top world class athletes in the 10,000 meters.

Although the plan just offered has been widely used, there is more than one road to Rome. On the American calendar, the summer and fall months are generally used as time to build strength and stamina. Not all athletes assume that cross country racing is a must during the fall. There are those who feel that cross country is non-specific. If athletes do not concentrate on cross country, then they do well in the long term to concentrate on their known weakness in preparation for the precompetition/competition season, with an eye on improvement.

The following is a secondary program which has proved very popular and successful on the American scene:

Determine what your max speed is for the one mile, then determine the level you will train at (Table 7.6). Column A is divided into 11 different levels. Column B is the maximum speed that you would run the repeat miles after 3 months of building up to that speed. You would spend several weeks at each percentage level, starting at 82% (82 – 85 – 88 – 91 or 92). Once the body has adapted, move up to the next level of your maximum speed.

Example:

Convert maximum speed to seconds	(4:00 mile = 240 seconds)
Multiply by 100	(24000)
Divide by % intensity you desire	Ex: 92%
Time of repeat miles =	4:20

At the percentages quoted (82–85–88–92), the repeat mile times for a Level I runner using the formula above would be 4:52, 4:42, 4:32, 4:20 respectively. Column C in Table 7.6 illustrates the pace per mile (89%) you would try to maintain throughout the 10,000 meter race. Column D shows the number of miles to practice for each level. Column E relates the athletic strata at the level you should be for both male and female runners.

	A 100 %	B 91% ± 2	C 89% ± 1
Level	Max Speed for one mile	Intensity of repeat miles	Race Pace and performance goal for 10,000
1	4:00 - 100%	4:20 - 92%	4:30 27:50 ± 10
2	4:10 - 100%	4:30 - 92%	4:40 28:50 ± 10
3	4:20 - 100%	4:45 - 91%	4:55 30:20 ± 10
4	4:30 - 100%	4:55 - 91%	5:05 31:20 ± 10
5	4:40 - 100%	5:05 - 91%	5:15 32:20 ± 10
6	4:50 - 100%	5:15 - 92%	5:25 33:30 ± 10
7	5:00 - 100%	5:25 - 92%	5:35 34:30 ± 10
8	5:10 - 100%	5:35 - 92%	5:45 35:30 ± 10
9	5:20 - 100%	5:45 - 92%	5:55 36:30 ± 10
10	5:30 - 100%	6:00 - 91%	6:05 37:30 ± 10
11	5:40 - 100%	6:10 - 91%	6:20 39:00 ± 10

	D Number of miles to be practiced	Volume	*E* Athletic Level	Volume
A	Elite Level Athlete	- 7	Elite Male Level	- 2-3
B	National Class Athlete	- 6	Intermediate Male Level	- 4-5
C	Experienced Collegiate	- 5	Beginning Male Level	- 6-7-8
D	Beginning Collegiate	- 4	Elite Female Level	- 3-4-5
E	High School	- 3	Intermediate Female Level	- 6-7-8
			Beginning Female Level	- 9-10-11

TABLE 7.6 The relationship between volume, intensity and classification levels for 10,000 meter training and performance.

Table 7.7 describes the intensity of aerobic workouts at the level predetermined from your maximum mile speed. One day every two weeks, a level 1 runner will run a hard tempo run at 5:00 per mile for the number of miles described by his/her ability level in Column D. One day a week the athlete should do a one hour run at Columns B and E intensity. This is referred to as a medium continuous run. Finally, Columns C and F describe the intensities to be practiced twice per week.

	A	**B**	**C**
	100 %	75%	70%
Level	*Hard Tempo Continuous Run*	*1 Hour Run Aerobic*	*1.5 - 2 Hour Run Steady State*
	Pace Per Mile	Pace Per Mile	Pace Per Mile
1	5:00	5:20	5:40
2	5:10	5:30	5:55
3	5:25	5:45	6:10
4	5:35	6:00	6:25
5	5:50	6:10	6:35
6	6:00	6:25	6:50
7	6:15	6:35	7:05
8	6:25	6:50	7:20
9	6:40	7:05	7:35
10	6:50	7:15	7:45
11	7:00	7:30	8:00

	D	***E***	***F***
Level	*160 -190 HR*	*150 -165 HR*	*130 - 150 HR*
Elite	10 - 12 miles	These runs can be used as recovery runs and correlate to an SCR or an MCR. These should be practiced at least once per week. Adhere to minutes per mile pace.	This SCR or LSD run should be practiced at least two times per week. Duration of the run is more important than the mileage. Adhere to minutes per mile pace.
National	8 - 10 miles		
Local	6 - 8 miles		
Begin. Coll.	4 - 6 miles		
Begin. H.S.	2 - 4 miles		
This effort should be practiced at least every 14 days. This is considered a Fast Continuous Run (FCR).			

TABLE 7.7 Intensity of aerobic workouts for 10,000 meter training.

Table 7.8 illustrates the 400 meter repetitions to be run on the track for inclusion in a 10,000 meter workout. The levels are the same as in Table 7.6 and 7.7.

In conclusion to this plan, a typical microcycle would be:

1 day of repeated miles

1 day of hard tempo run

1 day of a 1 1/2 to 2 hour run

2 days of a steady state or recovery run

1 day of repeated 400's

1 day for a time trial or competition at a shorter or longer than normal race distance

	Max Speed for 400	400 Meter Training Ratio		
		A	*B*	*C*
		1:1	1:1.5	1:2
Level		10 - 12	14 - 16	18 - 20
1	48	58 - 60	62 - 64	64 - 66
2	50	60 - 62	64 - 66	66 - 68
3	52	62 - 64	66 - 68	68 - 70
4	54	64 - 66	68 - 70	70 - 72
5	56	66 - 68	70 - 72	72 - 74
6	58	68 - 70	72 - 74	74 - 76
7	60	70 - 72	74 - 76	76 - 78
8	62	72 - 74	76 - 78	78 - 80
9	64	74 - 76	78 - 80	82 - 84
10	66	76 - 78	80 - 82	84 - 86
11	68	78 - 80	82 - 84	86 - 88

TABLE 7.8 The maximum speed in the 400 determines the work to rest ratio and the number of 400s to be run during the precompetitive (C), competitive (B) and peaking periods (A) of a season.

Peaking Tendencies

The 10,000 meter race is run at close to 90-92% of velocity of $V0_2$ max, whereas the 5,000 is run at close to 100% $V0_2$ max. The speed at 100% $V0_2$ max has been defined as one's critical speed. These events are performed in critical (5,000m) or near critical speed (10,000m). Athletes with a fiber distribution dominated by slow twitch fibers are genetically best suited for the 5,000 and 10,000m events.

There are two components that have to be developed to gain the greatest benefit in peaking for a great 10,000m. The athlete has already developed close to max aerobic power by using segments of 1–2 km runs. What I would like to recommend has been determined by my athletes as the epitome in peaking for the 10,000.

After the key date (most important race of the year) has been determined, you go back four weeks to start the peaking macrophase and carry out the following workouts on Thursday of each week.

4th week before championship

Run a two-mile distance (3218 meters) at $V0_2$ max. Recover for 15–20 minutes and run 3 x 1 mile at slightly faster than $vV0_2$ speed. Complete your session by running a total of 10 miles for the day. Reduce total weekly volume to 90% of what you were doing.

3rd week before championship

Run a two-mile distance (3218 meters) again at $vV0_2$ max. Recover for 15–20 minutes and run 2 x 1 mile, faster than the repeat miles the first time you tried them. Reduce total weekly volume by 20% of original volume.

2nd week before championship

Repeat the 2 mile run of the previous two weeks, recover for 15–20 minutes, then prepare yourself for an all–out 1 mile run. Your volume has been reduced by 30% of the original.

Week of the championship

Run an all–out mile on Monday. Reduce weekly volume to 60%. Make travel arrangements and prepare for the greatest race of your life.

Once this peaking program has been carried out, you have worked at 100% of your max aerobic power. Generally speaking, you may have even increased it. At the same time, your mile repeats are faster than critical speed after the two mile runs. This probably raised your anaerobic threshold higher than it had been previously. The development of a state of acidosis in repeat miles makes the option of inserting supra–race pace surges more viable as you run your 10,000.

Racing Tactics

The 10,000 meter race offers the racer two distinctly different race plans. Great tempo running allows the athlete the opportunity to cover the distance at a very even pace. Secondly, it is a race that allows athletes to have changes of pace, slowing down and then surging to a greater speed. This type of race plan develops an onset of fatigue between 7,000 - 8,000 meters, if not sooner. The last kilometer is the fastest, the first is the second fastest, and the seventh and eighth are the slowest.

The runner who accelerates first in the last lap with a prolonged finishing burst is usually the winner. This tactic does not allow the competitor an opportunity for a counter move because the distance is too long. The following points should be considered in developing a race plan for the 10,000.

A. From both a psychological and tactical point of view, the 10,000 has similarities to the 5,000 meters.

B. The 5,000 is run at close to 100% vVo_2, whereas, the 10,000 is run closer to 92% of vVo_2. With this point clearly understood, also remember that, with optimal development, your lactate threshold will probably not exceed much beyond 88-90% of VO2 max. There are, however, athletes who have lactate thresholds in the 90's.

C. Training must include interval sessions and tempo runs with the correct percentage of VO_2 max velocity as determined by testing protocols. This will provide the athlete with the most specific type of training and provide the opportunity for determining the correct pace during the 10,000.

D. Unless you can raise your VO_2 max or lactate threshold so high that a winning race pace is within aerobic limits, a gradual accumulation of acidosis is likely.

E. All good 10,000 runners must have a strong knowledge of pace and the geophysical conditions in which they will be running. There is a difference between running a race in the hot, humid climate of the southern United States as compared to the cool ionic environment of a Scandinavian city. It has been established that there might be as much as 30 seconds less in the 10,000m race time in Scandanavia.

F. In preparation for key competition, athletes must raise their lactate ventilatory threshold, their V02 max, and sharpen their speed. Practices must include strong finishes toward the end so that they might carry this philosophy over into their meets.

G. When considering the world record paces for the 10,000m, the men have a 64.7 second pace/400 and the women a 72.6 second pace/400. In the 5,000 the men's record is a 62.3 second pace/400 and the women's a 70.2 second pace. This is a 4.5% difference for the men and a 3.4 % difference for the women. I mention this because there is a tremendous amount of stress in trying to run each 400 meter lap one second faster for 25 laps beyond your optimal management. It becomes vitally important that the athlete develop pace judgment under all conditions.

H. All athletes must develop the ability to sustain excellent concentration (focus) for pace identification during the entire distance of the race. Falling asleep for just a few seconds can throw the runner off the pace to the extent that he/she will not experience any degree of success.

I. The ability to concentrate can best be developed by being mentally and physically rested before an important competition.

J. The athlete must also keep in mind the high energy cost involved in fighting a head-wind. One must always run in the aerodynamic shadow of the opponent. A high ambient temperature and high humidity will not allow the athlete's perspiration to evaporate and cool the body.

K. When preparing for the final mile or kilometer, be ready to deliver a fast 2-3-4 laps at the end of the race. International competition has shown that the last 400 in a good race has produced a 53.5 to 54.9 second 400. Your training must include the ability to produce a fast 400 on the 25th lap of your 10,000.

L. All athletes must be well prepared, realistic, and thoughtful before every race. Not only must the athlete have an accurate sense of pace, estimating what can be done, but keep it as even as possible for good economy of effort. The athlete must maintain physical and mental contact with his/her competitors. Remember that satisfaction comes not just from winning, but from knowing that you ran the best race possible, and that your quality of effort was excellent.

Study Guide

1. What are the aerobic and anaerobic energy requirements of the 10,000 meter run?

2. What are the factors that determine a greater oxygen utilization?

3. What workloads produce the most effective aerobic power?

4. What does critical speed mean?

5. What is the philosophy behind the 30 km test run?

6. What is the benefit of having a 10 –12 or 14 day microcycle over a 7 day period?

7. What percent of the $V0_2$ max will initiate the recruitment of fast twitch fibers (FTF) and why is this intensity important?

8. The race tactics for the 5,000 and 10,000 have similarities. What are they? Why is it dangerous to deviate from race tactics?

9. Why is it necessary to develop mental concentration during a 10,000 meter race?

10. What must be considered when developing sound racing tactics?

Rick Robirds winning his third straight 10,000 m. National Championship.

Team elation after all five ran a superb 10,000 meter race with only 4 seconds separating all five runners.

Rick Robirds: 1988, 1989, and 1990 Outdoor National 10,000m Champion.

8 The Marathon

" In the marathon —
the contest is not so much between the runner
and other runners, but in the tradition of the classic drama
between man and the gods.
The gods in this instance being represented by
distance, heat and time. "

- John Hopkins 1965

Overview

Along with an historical overview of distance running, Chapter 8 describes the proper fuel mixture in marathon racing and the energy systems involved. This includes marathon training, volumes, strength running and specific paces with typical 70 – 80 mile and 120 – 140 mile microcycles.

Introduction

From the day that Phiddipides ran from Marathon to Athens, (a distance of 24 miles) to announce "We have won!" the world has been fascinated with the marathon and distance running.

My personal fascination with distance running began in 1962 when Mexico City was designated as the site for the XIX Olympic Games in 1968. Many believed that the altitude would pose a problem for distance athletes. Medical doctors, sports scientists, exercise physiologists, coaches, athletes and trainers began to investigate the many physiological problems imposed by performance in a rarefied atmosphere. The results of their many investigations laid the ground work for the guidelines which were used then and continue to be used even today. Research on these problems continues at a prolific rate and, as modern medical technology improves, we will see improvement in marathon performances.

About the same time that preparation for the 1968 Games was going on, there were a group of citizens in Alamosa, Colorado, (which had the same altitude and geophysical conditions as those found in Mexico City) who organized the Alamosa

Olympic Development Committee. The function of this committee was to gain local, state, and national support to host athletic training and competition camps in preparation for Mexico City. Basketball and wrestling Olympians trained in Alamosa at the same time that cycling and middle distance runners were training there. As a result, the Olympic trials in the marathon and the 20 and 50 kilometers walks were held in Alamosa. There were two international marathons held in 1966 and 1967 that led to the trials in 1968.

The motivation I received personally from all of this activity led to my study of physiology, exercise physiology, and coaching. This 30 year interest had led to my involvement with the National Federation, the AAU, TAC/USA, (presently USATF), as well as membership in both the men's and women's Track and Field Olympic committee and the development of Alamosa as a world–recognized center for distance training.

Olympic champions, entire national marathon teams from Japan, Korea, Finland, and Italy, and elite athletes from 21 countries have come to Alamosa to train. The lecture circuit has taken me to 5 continents to lecture and work with athletes and coaches. From all of these experiences, I have discussed and made recommendations on the many aspects of distance and marathon training.

I. Historical Overview

This short, historical account is included to show both the evolution in times, training systems and records accomplished by those who laid the groundwork for the remarkable accomplishments of today's marathon. Although, in most cases, athletes did not keep training logs or any account of what they did from year to year, the historical accounts obtained from Tim Noakes' book *Lore of Running*, reveals some philosophical approaches. It presents brief statements showing how far we have progressed in training methodologies.

Captain Barclay in 1806 ran 160 kilometers (100 miles) in 19 hours. Three years later he ran 1 mile every hour for 1000 consecutive hours (41 days and 16 hours).

Walter George in 1882, at the age of 23, set world marks at every distance from the three-quarter mile to 10 miles. During his career he won many British track and cross country titles. During this period he lowered the mile record from 4:25.5 to 4:12.8. Later he ran a 10 mile distance in 49:29. All of these achievements were made on a training program of two miles a day.

Joe Binks in 1902 ran outstanding times in the mile on a training menu of one workout per week. The workout consisted of 5-6 x 110 yards at top speeds plus a fast 2–300 at the end of the workout.

Al Shrubb. one of the greatest British champions, set amateur and professional records at distances from 2–5 miles and 8–11 miles. His most remarkable record was a 1 hour run of 11 miles and 1137 yards. In a comparison of training methods, Shrubb trained considerably more than the previous British runners mentioned. At times he approached and exceeded 42 miles per week. He had great respect for American runners and believed that they were more serious and dedicated than the British.

Hannes Kolehmainen was the first in a dynasty of outstanding Finnish runners. Unfortunately, there are no records of his training regimen to be found. His accomplishments, however, are a testament to his career. In the 1912 Stockholm Olympic Games, he earned victories in the 5000 with a time of 14:36.6, the 10,000 in 31:20.8 and the 8000 meter cross country run. In the 3000 meter team race, his leg posted a then world record of 8:36.6. In the Olympic games in 1920, hosted by the city of Antwerp, he won the gold in the marathon by running it in a time of 2.32:35.8.

Clarence de Mar One cannot think of the marathon without remembering the many legendary performances of Clarence de Mar. His participation in the Boston Marathon helped popularize that event forever. He won the Boston Marathon seven times, his last victory at the age of 41. He participated in the Olympic Games in 1912, 1924, and 1928. Subject to many scientific experiments, his high VO_2 max (76mls), good running economy, low levels of lactate during exercise, and high anaerobic thresholds are a tribute to his genetics, training, and lifestyle. Although very little is known of his training, it has been well documented that he would train 100 mile weeks with long runs of 20 miles and speed runs of 10 miles. Even by today's standards, this is very good training protocol.

Paavo Nurmi The Flying Finn who won a total of six Olympic medals, including three in the marathon, was first in a team event and won second in two other events. During his running career, he set nineteen world records. The Finnish winters did not allow him to train very much. His big thrust was during the summer months. He always felt that his training was less than optimal both in volume and intensity. During his later years (when he trained at marathon distances and was ready to post a great time after having run a practice marathon of 2:29 04), Nurmi was declared a professional and was not allowed to participate in the 1932 Olympic

games hosted in Los Angeles. During his running career, he completely dominated distance running.

Emil Zatopek The first and only man in Olympic history to have won the three distance events: the 5,000 meters, the 10,000 meters, and the marathon. His training discipline and competitive style, even to this day, are legendary. His training logs have been made available to all. He believed in interval training and speed work and had very little rest between repetitions. His classic workouts in the 400 were from 20 to 50 x 400 and the total volume was between 18 kms (11 miles) to 30 kms (18.6 miles) daily. Even by today's standards this would be considered very hard, and his workouts occurred almost 50 years ago. His philosophy and approach to setting goals were extremely realistic. Like Nurmi, he also dominated endurance running during his competitive career.

Jim Peters, between 1952 and 1954, became the first man to break the 2:20.00 barrier for the marathon, lowering the world marathon record from 2:26:07 to 2:17:39. At the time of his retirement, he held four of the six fastest ever marathon times. His training logs reveal that his weekly training volumes and intensities increased over a period of time. During the first four years, Jim ran all three races (track, cross country and road races), the longest being 16 kms. Over a period of two years, his training volume went from 27kms (17 miles) at a 4:00 km pace to 100 kms per week. Later he began running twice a day and improved his speed per kilometer to around 3:37. As his career went on, he began logging 100 mile weeks with concentrations of 10,000 meter specialization. He then posted a best of 28:57.8. His recommendations to all were not to overtrain and, after a marathon, allow the body sufficient recovery time before attempting another race. Above all, he believed that marathon training should be at the pace anticipated during the race.

Leonard "Buddy" Edelen prepped in Sioux Falls, South Dakota where he was the state mile champion. Later he attended the University of Minnesota where he achieved conference and national championships in track and cross country. He always felt that American distance running was "in a sad state of affairs" and moved to Europe after the 1958 season. In the five years that followed, he competed in Europe and achieved great success by breaking eight American records. In 1962 he won the British AAA 10 mile race. Buddy competed in 13 marathons, winning seven of them. His greatest achievement came when running a world's best in the marathon by posting a 2:14:28 in the Polytechnic Marathon from Windsor Castle to Chiswick.

Not being blessed with natural speed, he relied on a training program which included:

1. 100 miles a week
2. 1 long run weekly of 20–23 miles
3. 1 midweek run of 12–15 miles, faster than the long run pace
4. Interval workout of 400's–800's with high volume
5. One speed workout (Keep in mind he had only 0.55 – 1.58 speed)

Buddy's greatest asset was his mental tenacity which allowed him to tolerate great pain throughout the duration of the marathon. Considered by many as the pioneer of present day distance running in America, he did much to develop present day philosophies in marathoning.

Derek Clayton, an Australian, was the first to break the 2:10:00 and 2:09:00 time barriers in the marathon. He established a world's best at 2:08:34 in Antwerp in 1969, a record which stood for 12 years. This was later broken by Rob de Castella in the 1981 Fukuoka Marathon. His aspirations in track & field were to run the mile, but he soon found out he didn't possess sufficient speed. His new found success at the longer distance led to a career in the marathon. He trained very hard and consistently. 120–160 miles (192-256 kms) per week. On several occasions he ran in excess of 200 miles. In addition, he ran 4x1 mile for his interval training. Early on, he would overtrain and not pay particular attention to injuries. This overtraining resulted in numerous injuries which put him on the operating table. By his own admission, he learned to recognize overtraining in later years. He would take a little time off and end up running the best marathons of his life, a condition referred to as the "Zatopek Phenomenon".

Frank Shorter was extremely successful in marathoning. He was considered the man who started the running explosion in the United States and was labeled as the person who reinvented the marathon. He was a gold medalist in Munich in 1972 and a silver medalist in 1976 in Montreal. There was a string of four victories in Fukuoka from 1970–1974. Shorter's career had a slow beginning and he was not a schoolboy champion. (This point is made to illustrate that you can strive for international experience without success in racing at a young age.) His career shows that he trained as a track and cross country athlete, where he specialized in the 10,000. He even showed great success at 5,000 meters and the 2 mile. What is known about his training, shows that he trained with a 10,000 meter flavor and ran intervals of 4 x 1200m in 3:06-3:12 and 12 x 400 at 60-61. His longest distance run was 32 kms (approximately 20 miles), with the first 16 km in 4:00 flat and the last 16 km at close to 3:07, for a negative split run. He did much to influence track distance running in the United States and is still very active in this pursuit.

Dave Bedford was the former world record holder in the 10,000 meter with a time of 27:30.8 set in 1973. His regimen consisted of three running workouts a day, sometimes reaching volumes of 320kms (189 – 200 miles) per week. Normally his training was around 260–280 kms (162–174 miles) per week. Mention of these high volumes is only to show that many runners do run mega-volumes. His best races always came at a time when he was recovering from an injury, a true example of "The Zatopek Phenomenon."

Robert de Castella started his running career at the early age of 12. Pat Clohessy, Australian national coach, started training Robert seriously at 14 years of age. By the time he was 18 years old, his training program consisted of 60-80 kms (37–50 miles) per week. By the time he was a senior runner, his training consisted of 208 kms (128–130 miles) per week. Within that volume he would do an a.m. run of 10 kms daily, with 2 long runs on Saturday and Sunday consisting of 21 and 36 kms (13–22 miles), respectively. In the p.m. he stayed with 10k on Tuesday and Thursday but increased his volume on Monday (16 kms), Wednesday (29 kms) and Friday (18 kms). His speed work was done on Thursday p.m. by running 8 x 400 – 63.64 seconds with a 45 second interval after first running a 38:00 minute 10 k. In addition, on Saturday a.m. he would run 6 x 100 after his 21 km run.

This type of training produced the world's best marathon for an out and back course of 2:08:18 at Fukuoka in 1981. Two years later, in 1983, Rob won marathons in Brisbane and Helsinki in 1983. His training intensity for the long runs was at 3:54-4:03 km, which is 6:15-6:30 pace. Rob went on to win other marathons and shorter distance races. He became a revered sportsman worldwide.

Steve Jones, remarkable as it may seem, was quite by accident a runner at all. As a cadet, Steve was enticed to run an intersquadron cross country race where he finished 5th. When he joined the Royal Air Force, he began training seriously for the first time. His greatest successes came in a third place finish in the World Cross Country Championships in the Meadowlands in 1984. That same year he had an eighth place finishing the 10,000 meter in the Los Angeles Olympics. On the 21st of October 1984, he stunned the world by lowering the world record in the marathon to 2:08:05. From there he has won many other races and has become one of the greatest marathoners of our time.

Jones' basic preparation consisted of 135–180 kms (84–112 miles) per week. His concentration speed has been greater than other marathoners in that he concentrates on it four sessions per week. On Tuesday mornings he runs 4 x 5

minutes hard during his 11 km run. Thursday mornings he does 10 hill repetitions very hard. On Wednesday afternoon he runs a cross country or track race. Saturday p.m. runs include either 16 x 1 minute, 10 x 2 minute or 16–24 45 second runs. In addition, his long Sunday runs are done at 3:45/km. Mondays he does a 12–16 km run in 3:07/km in the a.m. and 19 kms at 3:07 each in the pm. One can readily see that he has a more than usual concentration on speed than most marathoners. His primary objective in training has been to improve his track times for 10,000 which ultimately has led to faster marathon times.

Carlos Lopes began running in his late teens and, by 1975, won his first world cross country championship. In 1976 he was second to Lasse Viren in the Montreal Olympics. He was virtually out of sight from 1976-1983, however, in 1983, he gave the world notice of what was to come. At 35 years of age in March 1983, he was second in the Rotterdam marathon where he ran an excellent 2:08:39. In 1984 he won his second world cross country championship. In 1984 he attempted the Rotterdam marathon for the second time, dropping out at 29 km. He later stated that he just wanted to see how fit he was and wanted to save himself for the Los Angeles Olympic marathon a couple of months later. Three months before L.A., he ran the worlds second fastest 10,000 in a time of 27:17:48. Five weeks later he won his second ever completed marathon in a time of 2:09:21. Ten weeks later he ran second in a marathon in 2:09:06. In 1985 he won his third world cross country championship followed by his Rotterdam marathon victory, in which he lowered the world record by 54 seconds to take the victory in 2:07:11. In a short period, from 1983 – 1985, he moved from a superstar to a legend and became an inspiration to all of those who thought they were over–the–hill at age 35.

Although Lopes's training logs have not been available, in 1985 I was able to observe his workouts in Lisbon, Portugal, prior to the 1985 world cross country championships. Later, visiting with his coach, I determined that speed workouts were the focus of his training. This speed training was carried out through most of the year. His long runs seldom went beyond 2 hours, covering approximately 35 kms. Again, he is a prime example that 10,000 meter trained marathoners have achieved the greatest success.

"He who would ignite a fire in others must himself glow."
Coach Joe Vigil

II. The Necessary Fuel Mixture in Marathon Racing

A knowledge of diet and nutrition is important to all athletic activities, but becomes more important for the longer duration events. In the marathon it is absolutely necessary for the athlete to understand the metabolic dynamics of all caloric nutrients in order to achieve a successful performance.

The marathon runner must use a mixture of fuels, fats and carbohydrates during the entire distance. The athlete's accumulation of fatty acids in the blood stream will be low because he/she will be rested and will have eaten a meal high in carbohydrates a few hours before the start of the marathon. This insures that most muscle tissue will be using glucose. Even during the race, the concentration of fatty acids in the blood will rise, however, it will not exceed that of the glucose. With this fact in mind, one might think that glucose would be the preferred energy fuel and used in preference to fatty acids; it is not. When glucose and fatty acids are both available to the muscle tissue, the fatty acids are oxidized in preference.

Of more importance to the runner, is that a control system insures as much fatty acid oxidation as possible takes place (up to about 50% of the maximum oxygen uptake) but the remainder of the energy is generated by the oxidation of blood glucose or muscle glycogen. This mechanism always allows a mixture of fuels, carbohydrates and fats to be burned, provided both are available. This physiologic principle allows the advantage of sparing carbohydrates so that the limited stores will last longer.

The importance of this mechanism is further emphasized by the fact that an elite runner, using only glucose as a source of energy, requires 5–6 gms. of glucose per minute to maintain speeds of 11–12 miles per hour (5:00 – 5:30 pace, a 2:11 – 2:24 marathon). This rate of glucose utilization will remove all glucose from the bloodstream (4 gms) in less than 1 minute.

Exhaustion occurs in a marathon runner when glycogen stores in the muscles are totally depleted. This means that ATP can no longer be synthesized from oxidation of carbohydrates. It must be obtained only from the oxidation of fatty acids. Fatty acids, however, can provide only about half of the energy required. Under this condition, the pace is decreased by 50%. For an elite runner, this would mean slowing down to an 10:00 to 11:00 minute per mile pace, or 5–6 mph, just above fast walking pace. This, for a well-trained marathoner is physically and mentally unacceptable.

The long training runs (20–30 miles) are very necessary for the marathoner because this activates the metabolic pathways for the precise activation of fatty acids from adipose tissue. This volume is necessary for the regulation of glucose utilization in relation to the rate of fatty acid oxidation. Failure of either of these mechanisms results in earlier onset of fatigue.

It is likely that, in a normal sedentary individual who eats three balanced meals a day, there is no reason to mobilize fatty acids from the fat stores except in periods of emotional or physical stress. Long training runs or periods of starvation that deplete liver glycogen stores (approximately 100 gms, 400 calories) are essential to train the fatty acid mobilization mechanism.

The integration between carbohydrate and fat mobilization also explains one further fact that is well known to both coach and athlete. A period of fasting for at least four hours (some prefer twelve hours) should precede the race. Only water should be ingested. Even fluids containing sugar or carbohydrates should be avoided. The ingestion of any carbohydrates increases the rate of secretion of insulin, consequently raising the plasma level of this hormone and preventing the mobilization of fatty acids from adipose tissue. This merely means that more glycogen will be used in the early part of the marathon, and, thus, increase the risk that glycogen stores will be depleted well before the end of the marathon.

Keep in mind the body has only about 450 gms (approximately 1800 calories of energy) of glycogen available. The demand for energy by a marathoner is such that, if it could be provided only from glycogen, it would last for less than 90 minutes. Of the available glycogen, we find 350 gms (1400 calories) in the muscle and 100 gms (400 calories) in the liver. As muscle glycogen is used, it is replaced by liver glycogen. The available evidence suggests that liver glycogen is depleted first. Consequently, fatigue coincides with muscle glycogen stores reaching low levels.

Some organs have an absolute requirement for glucose; therefore, the level of this fuel in the blood must be maintained. If this source is lowered significantly, it will initiate the onset of hypoglycemia in which the function of the brain is jeopardized. This is why glucose used by the muscle must be replaced by liver stores of glycogen.

Fat is a molecule composed of triglyceride molecules stored in fat cells throughout the body. Generally there are sufficient triglyceride reserves to last for three days and nights of marathon running. How then can it be mobilized? The triglyceride molecule is broken down into fatty acids, enters the blood, and

combines with the blood protein albumin. These components are separated in the blood and the fatty acids can then enter the muscle cell. Athletes and coaches must understand that low fatty acid utilization in the muscle cell occurs because of this tight protein binding in the blood. Evidence also suggests that this slow diffusion rate into the muscle restricts fatty acid oxidations in the muscle cell so that only 50% of the energy for marathoning comes from fatty acids. It is therefore essential that marathon runners learn to utilize both glucose and fatty acids for best efficiency. This allows good performance times while training or running the marathon.

There are several ways to determine this intensity of effort. One is to determine the velocity at which the respiratory quotient is from 0.95 to 1.0, where we are guaranteed that fat is being metabolized. The second is we must know the velocity we can achieve just below the anaerobic threshold level. We must be careful not to use the universally accepted 4mM/L, but, instead, use each athlete's own anaerobic threshold.

Training Points to Consider:

1. If the body's source of carbohydrates is depleted prior to a run (low carbohydrate diet), endurance is decreased in spite of the large fat stores. Exhaustion occurs very early in the endurance run after the runner has been on a low carbohydrate diet.

2. If the body's store of carbohydrates is increased prior to a run (high carbohydrate diet), endurance is increased. Most marathon runners attempt various dietary tricks to increase the glycogen level in the muscles prior to a run.

3. In ultra distance running (distances greater than the marathon), the power output gradually declines to about 50% of the maximum, as fat becomes the dominant fuel in the latter stages of the run.

III. Training for the Marathon

Before I start going over training protocols for the marathon, I would like to remind the coach and athlete of two very important concepts.

1. Insure that the body has the highest carbohydrate (glucose/glycogen) concentration possible prior to the start of the marathon.

2. Insure that much fatty acid oxidation takes place (about 50% of VO_2 max). The remainder of the energy is generated by the oxidation of

blood glucose or muscle glycogen. This physiological principle allows the advantage that it spares carbohydrates so that the limited stores will last longer.

Janssen, in his work on lactate training, has developed the following concepts which are displayed in Figure 8.1. All endurance activities burn fat. During surges, or in the final stages of the race during a breakaway, the athlete has to switch over to carbohydrate metabolism because fats supply insufficient energy. Carbohydrates are used for performing intensively and supply the most energy per unit of time. Whenever the intensity of exertion is lower, the burning of fats begins to play an important role.

Through training, it is possible to shift in the direction of burning up fats (Figure 8.1). Well trained athletes can perform up to 80% of their total capacity, using fats as their source of energy. When the athletes perform between 80–100%, they are using carbohydrates. The shift in which a greater % of fats are used allows the athlete to conserve carbohydrates for the later portions of the race.

From a philosophical point of view, a marathon runner must remain in condition the year round. This is achieved by training approximately 60–70 miles a week. Occasionally athletes might compete in an endurance race shorter than the marathon. At that point in the year, they would alter their training to provide for the needs of the race distance they are to compete in.

Once athletes have selected the marathon they are to compete in, they block out a 3 to 4 month period of time to prepare for it. At this point, all training is directed towards the marathon. As has been documented in previous sections of this book, the longer the distance, the more dependent one becomes on aerobic energy (Refer to Table 8.1).

	ENERGY SOURCE	
	Aerobic	*Anaerobic*
Marathon	97.5 %	2.5 %

TABLE 8.1 The percent of aerobic and anaerobic energy requirements for the marathon.

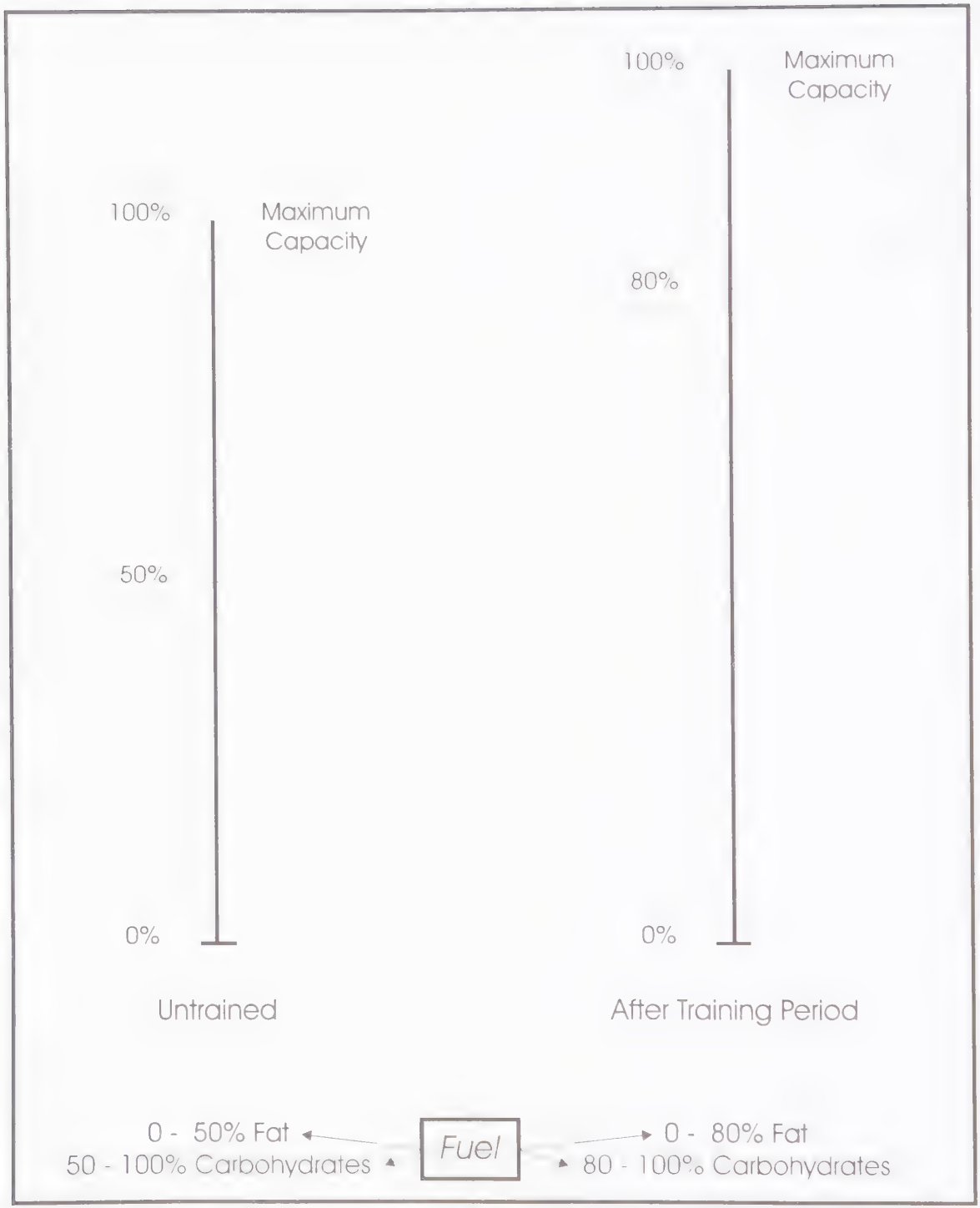


Figure 8.1 The effect of training on the utilization of fat and carbohydrate metabolism in the development of performance capacity.

Other questions to be asked, answered and understood so that the athlete might have positive direction and focus are:

1. *What type of marathon athlete are they?*

a.	Developmental	(First attempt at marathoning)	
b.	Intermediate	male -	2:20 - 2:40
		female-	2:35 - 3:00
c.	Elite	male -	2:10 - 2:20
		female-	2:25 - 2:35

2. *At what point are they in their training year?*

3. *How close to competition are they?*

4. *What emphasis must the athlete include in the training phases?*

   a. Restorative/Transition
   2 weeks
   - All athletes must be well rested, injury and disease free before undertaking a difficult training program to compete in a marathon distance.

   b. Aerobic Period
   4 weeks
   - Volume runs where the athlete should achieve close to the maximum distance in kms or miles per week.

   c. Strength Endurance
   4 weeks
   - Tempo cross country runs, hill training and repetition running are practiced.

   d. Specific Endurance
   4 - 6 weeks
   - Volume runs, specific pace and race pace running are implemented.

   e. Final Preparation
   2 - 3 weeks
   - Racing speed and reduced volume are practiced together with real concentration on diet.

I would next like to detail the advantages the athlete gains from *Volume Runs*, *Strength Runs* (cross country, hill training and repetition runs), *Specific Pace*, and *Racing Speed*.

The evolution of endurance takes years of practice. Competitive runners never stop all together, rather they train and transition endlessly throughout their careers. In addition, they make an attempt to vary the workload and run shorter races, either in cross country, road, or track.

VOLUME RUNS are those training sessions where one develops efficiency of the muscles of the lower legs and pelvic girdle. During this period, joint flexibility, muscular extensions and running technique are observed and possibly corrected. This nonspecific training is by no means secondary. Although the marathon race is the maximum expression of aerobic endurance (Table 8.1), most athletes experience difficulties that arise from incorrect running movements. Sometimes running is not sufficient in itself and ancillary training (such as flexibility and strength workouts) is necessary.

Volume runs should be increased progressively until the athlete is running 2–3 hours. Many athletes who are involved in mega-mileage programs learn to condition their bodies to a four hour run. This long distance volume allows the athlete to adjust to the discomforts of the event, such as heaviness of the legs, painful joints and tendons, as well as thirst. Remember to include slow pace running to allow the body to recover. Do maintenance work and regenerate from the previous road work as well as preparing the body for more intense running. Lastly, volume runs direct the body toward the metabolism of fatty acids.

STRENGTH RUNNING is of vital importance because this is the period of training in which the pace of the training run is faster. The pace should be at the anaerobic threshold level, slightly higher or slightly lower. This pace will allow heart and muscles not directly related to the exercise to burn the lactates being produced anaerobically. The AT runs, if practiced correctly, raise the threshold itself and, therefore, develop additional aerobic power. The athlete can also distinguish different muscle tensions (speed) and how these tensions feel at different paces. This allows the athlete to select the muscle effort which is most economical according to the situation.

Strength running will allow for further development of mechanical efficiency and develop qualities required for competitions over shorter distances. The variation of paces (different from volume training) are also a refreshing change in

training. I recommend that beginning marathoners not attempt more than two marathons per year and no more than three for experienced marathoners. The different types of runs which can be included in strength running are tempo runs, Fartlek running, cross country running, and hill running (where undulatory runs or repetitions up a hill are practiced). In addition, racing at various distances will enhance the buildup of strength.

SPECIFIC PACE running is of extreme importance in marathoning. This pace is the best drill to induce specific adaptation of energy metabolism, teaching muscles to use the proper fuel mixture of glycogen/fatty acids. This pace must be practiced frequently and increase distance progressively during the specific endurance period. Eventually it can be maintained for 2–3 hours. The athlete must learn to recognize the sensation of effort produced by this pace and not go beyond it. The emotional control of staying on pace for long distance is of great importance because it can be a carry–over into actual racing conditions. The athlete must recognize fully the importance of never running faster in the earlier stages of the marathon than the race pace calls for.

The athlete is well advised to study the pace charts in Table 8.2 and 8.3, and then determine the pace in either minutes/km or minutes/mile and adhere to it religiously when practicing race pace. I cannot emphasize this point too strongly.

RACE PACE is practiced when running a race of shorter distance. In order to elicit the proper neuromuscular recruitment patterning, one must increase the stimulus of intensity to the specific speed anticipated in the race.

Tables 8.4 and 8.5 illustrate the weekly volume an athlete would incorporate into each microcycle. These charts illustrate buildup weeks as well as unloading or recovery weeks. The last 2–3 weeks of preparation would allow sufficient rest and a period to peak for race day.

"80% of the people wallow in mediocrity and self-pity. Only about 20% see life's difficulties as a challenge. They have direction. They have goals. CROWD INTO THE UPPER 20%. *Do the BEST JOB you know how.*"

Coach Joe Vigil

Mile	5 miles	10 miles	15 miles	20 miles	Marathon
4:50	24:10	48:20	1:12.30	1:36.40	2:07.44
5:00	25:00	50:00	1:15:00	1:40:00	2:11:06
5:10	25:50	51:40	1:17:30	1:43:20	2:15:28
5:20	26:40	53:20	1:20:00	1:46:40	2:19:50
5:30	27:30	55:00	1:22:30	1:50:00	2:24:12
5:40	28:20	56:40	1:25:00	1:53:20	2:28:34
5:50	29:10	58:20	1:27:30	1:56:40	2:32:56
6:00	30:00	1:00:00	1:30:00	2:00:00	2:37:19
6:10	30:50	1:01:40	1:32:30	2:03:20	2:41:41
6:20	31:40	1:03:20	1:35:00	2:06:40	2:46:03
6:30	32:30	1:05:00	1:37:30	2:10:00	2:50:25
6:40	33:20	1:06:40	1:40:00	2:13:20	2:54:47
6:50	34:10	1:08:20	1:42:30	2:16:40	2:59:09
7:00	35:00	1:10:00	1:45:00	2:20:00	3:03:33
7:10	35:50	1:11:40	1:47:30	2:23:20	3:07:55
7:20	36:40	1:13:20	1:50:00	2:26:40	3:12:17
7:30	37:30	1:15:00	1:52:30	2:30:00	3:16:39
7:40	38:20	1:16:40	1:55:00	2:33:20	3:21:01
7:50	39:10	1:18:20	1:57:30	2:36:40	3:25:23
8:00	40:00	1:20:00	2:00:00	2:40:00	3:29:45
8:10	40:50	1:21:40	2:02:30	2:43:20	3:34:07
8:20	41:40	1:23:20	2:05:00	2:46:40	3:38:29
8:30	42:30	1:25:00	2:07:30	2:50:00	3:42:51
8:40	43:20	1:26:40	2:10:00	2:53:20	3:47:13
8:50	44:10	1:28:20	2:12:30	2:56:40	3:51:35
9:00	45:00	1:30:00	2:15:00	3:00:00	3:56:00
9:10	45:50	1:31:40	2:17:30	3:03:20	4:00:22
9:20	46:40	1:33:20	2:20:00	3:06:40	4:04:44
9:30	47:30	1:35:00	2:22:30	3:10:00	4:09:06
9:40	48:20	1:36:40	2:25:00	3:13:20	4:13:28
9:50	49:10	1:38:20	2:27:30	3:16:40	4:17:50

TABLE 8.2 Pacing charts for the marathon, utilizing miles.

Distance	1 km	8km	10km	16km	21.1 km	32 km	42.2 km
Time	3:00	24:00	30:00	48:00	1:03:18	1:36:00	2:06:36
(hr/min/sec)	3:10	25:22	31:42	50:43	1:06:53	1:41:26	2:13:46
	3:20	26:38	33:18	53:17	1:10:16	1:46:34	2:20:32
	3:30	28:00	35:00	56:00	1:13:51	1:52:00	2:27:42
	3:40	29:22	36:42	58:43	1:17:26	1:57:26	2:34:52
	3:50	30:38	38:18	1:01:17	1:20:49	2:02:34	2:41:38
	4:00	32:00	40:00	1:04:00	1:24:24	2:08:00	2:48:48
	4:10	33:22	41:42	1:06:43	1:27:59	2:13:26	2:55:18
	4:20	34:38	43:18	1:09:17	1:31:22	2:18:34	3:02:44
	4:30	36:00	45:00	1:12:00	1:34:27	2:24:00	3:09:54
	4:40	37:22	46:42	1:14:43	1:38:32	2:29:26	3:17:04
	4:50	38:38	48:18	1:17:17	1:41:25	2:34:34	3:23:50
	5:00	40:00	50:00	1:20:00	1:45:30	2:40:00	3:31:00
	5:10	41:22	51:42	1:22:43	1:49:05	2:45:26	3:38:10
	5:20	42:38	53:18	1:25:17	1:52:28	2:50:34	3:44:56
	5:30	44:00	50:00	1:28:00	1:56:03	2:56:00	3:52:06
	5:40	45:22	56:42	1:30:43	1:59:08	3:01:26	3:59:16
	5:50	46:38	58:18	1:33:17	2:03:01	3:06:34	4:06:02
	6:00	48:00	1:00:00	1:36:00	2:06:36	3:12:00	4:13:12
	6:10	49:22	1:01:42	1:38:43	2:10:11	3:17:26	4:20:29
	6:20	50:38	1:03:18	1:41:17	2:13:34	3:22:34	4:27:08
	6:30	52:00	1:05:00	1:44:00	2:17:09	3:28:00	4:34:18
	6:40	53:22	1:06:42	1:46:43	2:20:44	3:33:26	4:41:28
	6:50	54:38	1:08:18	1:49:17	2:24:07	3:38:34	4:48:14
	7:00	56:00	1:10:00	1:52:00	2:27:42	3:44:00	4:55:24
	7:10	57:22	1:11:42	1:54:43	2:31:17	3:45:24	5:02:34
	7:20	58:38	1:13:18	1:57:17	2:34:10	3:54:34	5:09:20
	7:30	1:00:00	1:15:00	2:00:00	2:38:15	4:00:00	5:16:30
	7:40	1:01:22	1:16:42	2:02:43	2:41:20	4:05:26	5:23:40
	7:50	1:02:38	1:18:18	2:05:17	2:45:13	4:10:34	5:30:26
	8:00	1:04:00	1:20:00	2:08:00	2:48:48	4:16:00	5:37:36
	8:10	1:05:22	1:21:42	2:10:43	2:52:23	4:21:26	5:44:46
	8:20	1:06:38	1:23:18	2:13:17	2:55:16	4:26:34	5:51:32
	8:30	1:08:00	1:25:00	2:16:00	2:59:21	4:32:00	5:58:42
	8:40	1:09:22	1:26:42	2:18:43	3:02:56	4:37:26	6:05:52
	8:50	1:10:38	1:28:18	2:21:17	3:06:19	4:42:34	6:12:38
	9:00	1:12:00	1:30:00	2:24:00	3:09:54	4:48:00	6:19:48
	9:10	1:13:22	1:31:42	2:26:43	3:13:59	4:53:26	6:26:58
	9:20	1:14:38	1:33:18	2:29:17	3:16:22	4:58:34	6:33:44
	9:30	1:16:00	1:35:00	2:32:00	3:20:27	5:04:00	6:40:54
	9:40	1:17:22	1:36:42	2:34:43	3:24:02	5:09:26	6:48:04
	9:50	1:18:38	1:38:18	2:37:17	3:27:25	5:14:34	6:54:50
	10:00	1:20:00	1:40:00	2:40:00	3:31:00	5:20:00	7:02:00

TABLE 8.3 Pacing schedule for the standard (42.2 km) marathon, using kilometers.

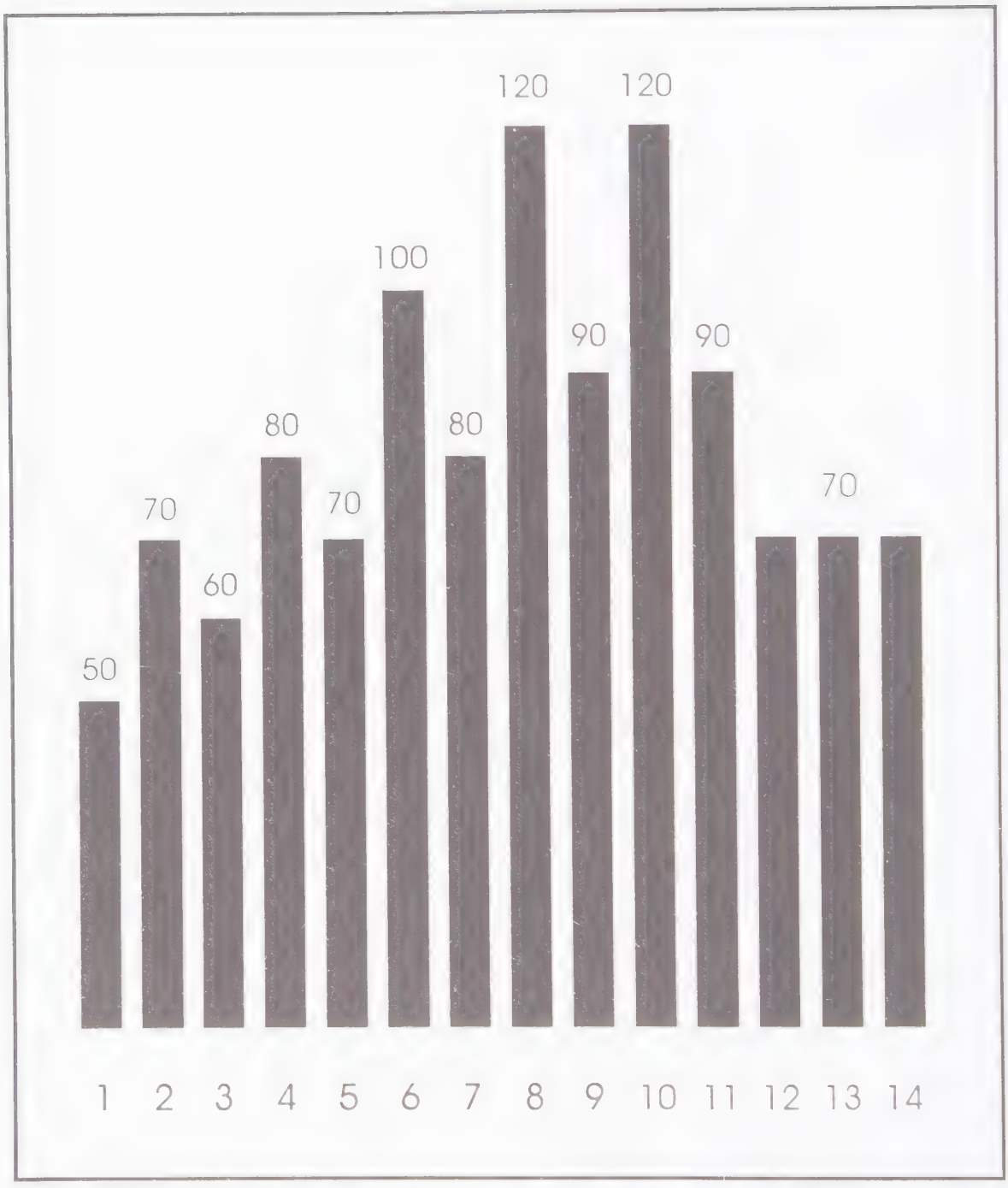


TABLE 8.4 Fourteen microcycles illustrating increases in weekly mileage. This table is used for emerging marathoners.

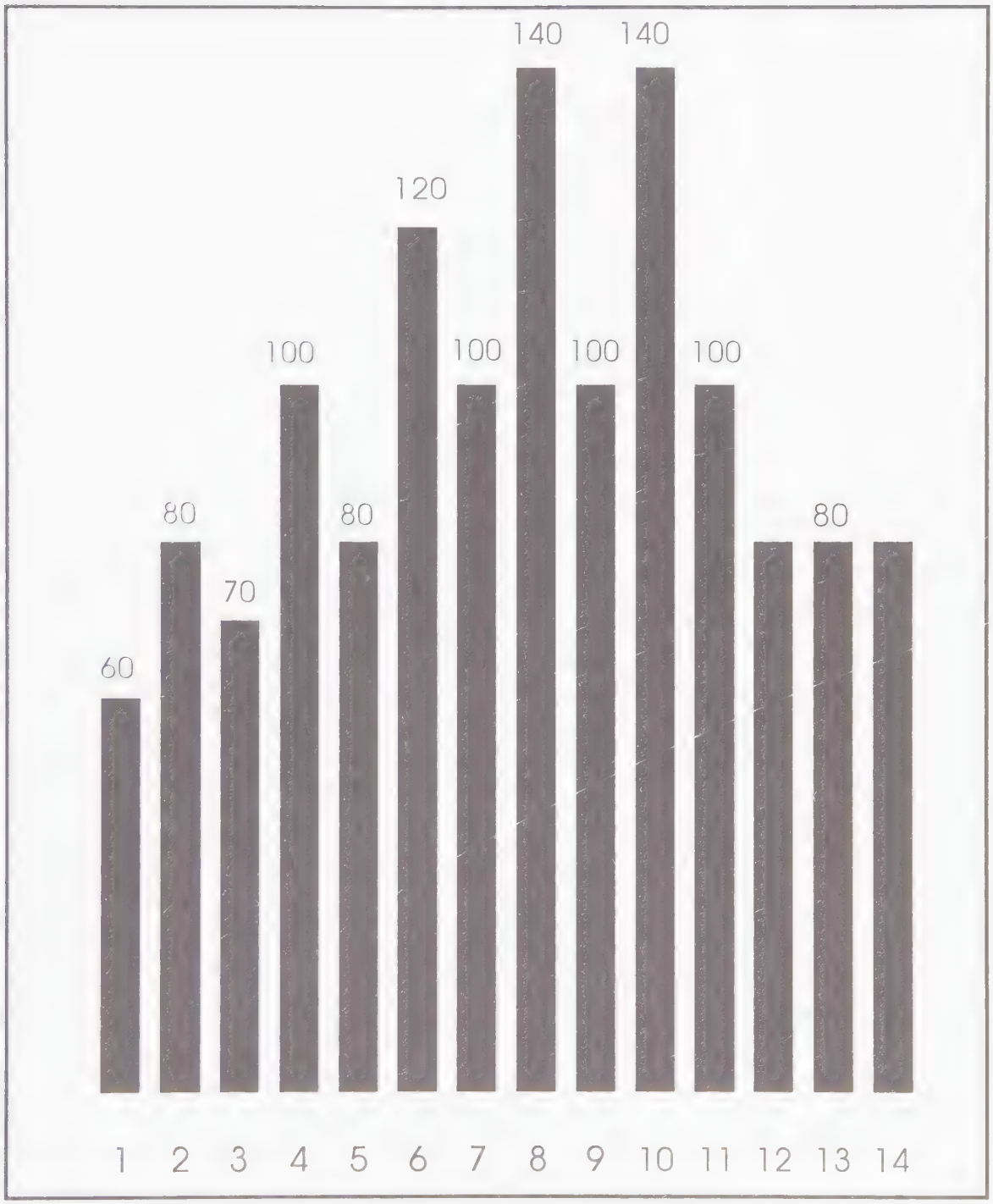


TABLE 8.5 This table illustrates progression in weekly volume. It can be utilized by more experienced marathoners who can handle the increased volume.

The following are two microcycles, one during the heavy volume week of 120–140 miles and one during the peaking phase of 70–80 miles.

DAY	A.M.	P.M.	TOTAL MILES
Sunday	24-27 miles 38-43 kms medium continuous run (MCR)	Rest	24 -27
Monday	12 miles 19kms easy continuous run (ECR)	8 miles 12.8 kms ECR	20
Tuesday	8miles 12.8 kms MCR, hill training undulating terrain	7 miles 12 kms MCR 6 strides (150 meters) on grass	15
Wednesday	15 miles 12 kms at race pace Fast continuous run (FCR)	7 miles 12 kms ECR	22
Thursday	12 miles 19kms ECR	6 x 1 mile 15 sec. faster than race pace 3 min interval between miles	18
Friday	10 miles 16 kms First 3 miles- 5:50/mile middle 4 miles- 5:30/mile last 3 miles- 5:20/mile	10 miles 16 kms ECR	20
Saturday	14 miles 22 kms ECR	6 miles 9.6 kms ECR	20

ECR = easy continuous run 140 HR (recovery run)
MCR = medium continuous run 140-160 HR utilization of fat metabolism
FCR = fast continuous run 160-180 HR race pace for next marathon
Repeat miles = 10-15 seconds faster than anticipated race pace.

Table 8.6 Daily workouts for a heavy volume microcycle.

In the last 3 weeks of preparation the athlete should hone his speed, reduce the volume as prescribed in Tables 8.4 and 8.5, and get as psychologically prepared as possible.

Day	*A.M.*	*P.M.*	*Total Miles*
Sunday	Reduce workouts from 20 miles to 18 miles to 16 miles the last Sunday before the competitions MCR	Rest	20-18-16
Monday	8 miles 12.8 kms ECR	7 miles 12 kms ECR	15
Tuesday	8 miles 12.8 kms ECR	Rest	8
Wednesday	10 miles 16 kms MCR	5 miles 8 kms 6 strides (150 Meters) on grass	15
Thursday	6 x 1 mile 15 seconds per mile faster than race pace	Rest	6
Friday	8 miles 12.8 kms ECR	5 miles 12 kms MCR	13
Saturday	Hard 10 mile 16 kms Anaerobic Threshold Run HR - 168-174 FCR		10
	2 weeks before marathon		
	1 week before marathon 6-8 mile anaerobic threshold run HR 168-174 FCR		

Table 8.7 Daily workouts for a peaking microcycle.

Study Guide

1. What is the evolution of both volume and intensity in marathon training?

2. What factor has contributed to the improvement of marathon times over the past decade?

3. What is the importance of the concept of "fat utilization and conservation of glycogen" while running a marathon?

4. What is the importance of fat and under what conditions is it used?

5. What is the relationship of fat and glycogen metabolism to pace time while marathoning?

6. What is meant by the "Zatopek Phenomenon"?

7. What are the differences between the aerobic period, strength endurance, and specific endurance?

8. Understand the weekly volume buildups and recovery in both emerging and elite runners.

9. What is the importance of understanding race pace for all distances?

10. What is the training philosophy between a work microcycle and peak microcycle?

A 1991 gathering of marathoners and coaches at a high altitude training camp: 3rd from left Coach Joe I. Vigil, 4th from left Gelindo Bordin 1988 Olympic Champion, 5th from left Anton Niemczak, Poland and 6th from left Coach Luciano Gigliotti and support staff.

Coach T. Hameda
National Japanese Distance
Coach in Alamosa with a 20
member marathon team.

Juma Ikaanga
Arusha, Tanzania.
Regarded as one of
the all time greats in
the marathon, with a
2:08.07 average
for his top six
marathons.

Coach Joe I. Vigil
who hosted and
served as high
altitude advisor to
both Japanese and
Korean marathon
teams in 1991.

9 Training in Exotic Environments

"It takes courage to push yourself
to places you have never been before -
to test your limits - - - to break through barriers."

Anonymous

Overview

Exotic environments referred to in this chapter are the altitude and hot and cold training environments. The controversy of altitude training is discussed along with altitude training guidelines. The effects of heat on strength and endurance and the effects of humidity, principles of dehydration/hydration and heat acclimatization are presented. Also the effects of cold are discussed in regard to adaptation, disturbances, dangers and precautions to take.

Introduction

Thirty-five years ago, during the 1960 Rome Olympics, a runner from Addis Ababa, Ethiopia won the marathon. Abebe Bikila was not widely known and only a few people realized that he lived and trained at an altitude of 2000-2500 meters above sea level. At that time, the effects of medium altitude on exercise capacity and sports performance were largely unknown. When Mexico City was selected as the site of the 1968 Olympic Games, it was realized just how little was known about the limitations for sports performance and training at altitudes close to 2300 meters.

During the period between 1960-1968, many research groups sponsored by athletic federations, national Olympic committees, medical agencies and universities all over the world, began to study the adaptations and practical aspects of acclimatization and training at all altitudes, especially at 2300 meters (7550 feet). Because Alamosa, Colorado (where I live and work) is at that altitude, it was easy to study the effect that a rarefied atmosphere had on both residents and athletes who would visit and train here. In addition, it had been the site for the 1968 Olympic trials in the marathon and 20-50 kilometer walks.

It was because of these factors that I developed an intense interest in altitude physiology and training. Since 1968, other international competitions have taken place at altitude, including the Pan American Games (1975) and the World University Games (1979), both in Mexico City .

During the 28 year period between 1968 and 1995, thousands of individuals and entire national teams have trained at altitude. Most medal winners in the middle/distance events in the Olympic Games from 1968 to the present have trained at altitude. Although a difference of opinion still exists as to the benefits of altitude training, it is my belief that there are more advantages than disadvantages. Some athletes have had unfavorable experiences at altitude. Had the proper altitude training methodology been implemented, the results might have been more beneficial.

Today there exists a growing belief among coaches, athletes, field physiologists and administrators that, with a properly implemented time period of training at altitude, significant increases in functional capacity and concomitant increases in sea level performances will occur. The majority of the elite middle and long distance runners from all countries today are taking advantage of this belief.

The Problem

The human body is an aerobic organism and requires a continuous and adequate supply of oxygen. To get this oxygen from the ambient atmosphere to the lungs and then to the muscle cells requires three different types of respiration: (1) external respiration from the atmosphere to the lungs, (2) internal respiration from the lungs into the blood, and (3) true respiration from the blood to the muscle cells, specifically the mitochondria where oxygen is utilized in the production of ATP (adenosine triphosphates).

In going from sea level to altitude, individuals are exposed to a progressive reduction in barometric pressure (P_A). This leads to a decrease in the partial pressure of oxygen in the inspired air, P_IO_2, a condition referred to as hypoxia (lack of adequate oxygen). In ascending to altitude, the organism will experience a reduction in oxygen uptake (P_AO_2) which will lead to decrements in the partial pressure of oxygen in the blood (P_AO_2) and to oxyhemoglobin saturation (S_AO_2). Figure 9.1 shows the relationship between altitude and the partial pressure of oxygen in the inspired air, alveolar air (lungs), arterial blood, and venous blood.

The organism will respond to this hypoxic effect by undergoing a number of physiological changes (summarized in Figure 9.2 and discussed later in greater detail). It is strongly believed by many that these organismic adaptations have the capacity to enhance sea level performance. Table 9.1 also shows the barometric pressure of oxygen at various altitudes.

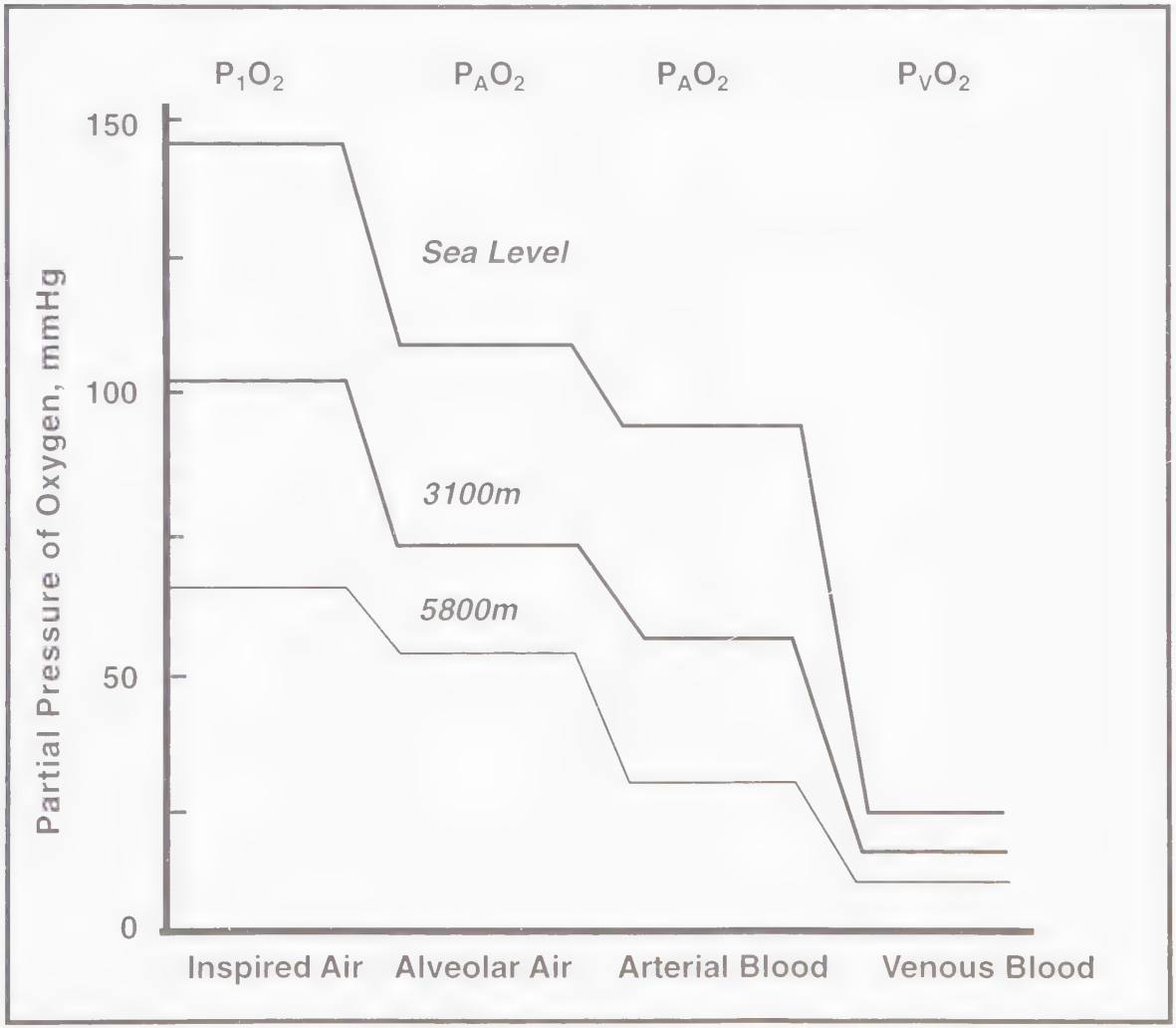


FIGURE 9.1 Relationship between altitude and the partial pressure of oxygen in inspired air (P_IO_2), alveolar air (P_AO_2), arterial blood (P_AO_2), and venous blood (P_VO_2). (Adapted from Haymes and Wells, Environment and Human Performance, 1986.)

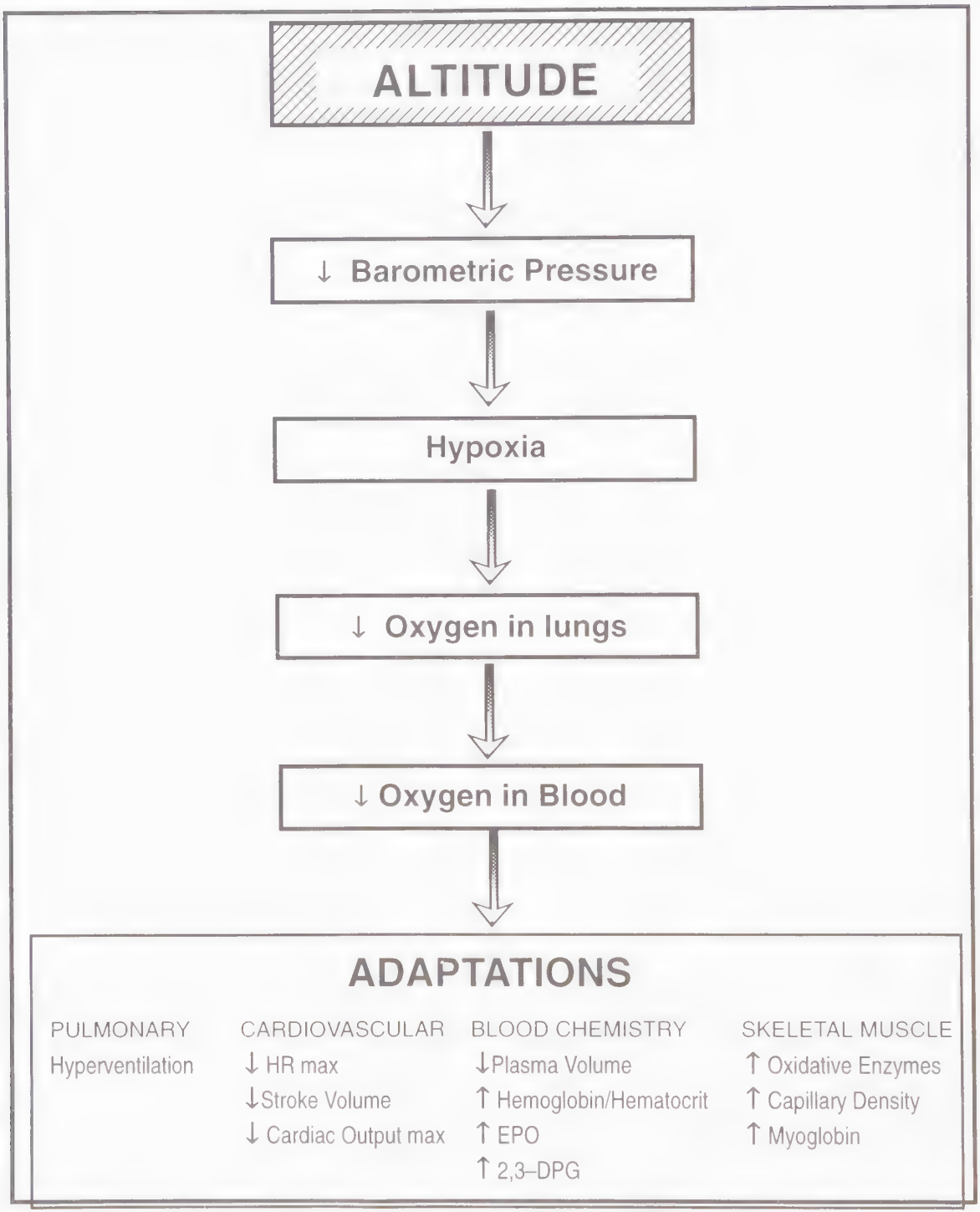


FIGURE 9.2 Physiological adaptations to altitude. (Prepared by Randall L. Wilbor, PhD, 1994 USOC, Colorado Springs, CO)

"While flatlanders are waiting for absolute proof of the benefits of altitude, those who live and/or train at altitude will continue to win the Olympic and World Championships."
Coach Joe Vigil

ALTITUDE

M	Ft.	Pressure PO_2 mm Hg	Tracheal Air mm Hg
0	0	760	149
500	1640	716	140
1000	3280	674	131
1500	4920	634	123
2000	6560	596	115
2500	8200	560	107
3000	9840	526	100
3500	11840	493	93
4000	13120	462	87
4500	14650	433	81
5000	16400	405	75
5500	18050	379	69
6000	19690	354	64
6500	21330	330	59
7000	22970	308	55
7500	24610	287	50
8000	26250	267	46
8500	27890	248	42
9000	29530	230	38
9500	31170	214	35
10000	32800	198	32
19215	63000	47	0

TABLE 9.1 Barometric pressure (standard atmosphere) at various altitudes and the pressure of oxygen after the inspired gas has been saturated with water vapor at 37 degrees Centigrade (tracheal air).

Pulmonary Adaptations

Ventilation

Upon exposure to altitude, the organism will experience an increase in ventilation (l/min). This condition is referred to as hyperventilation, an increase in breathing rate due to the decrease in oxygen availability. As a result of hyperventilation, a noticeable increase in oxygen pressure in the lungs will result, allowing for an adequate supply of oxygen for the body. This condition is most prominent the first few days at altitude, but it stabilizes after about one week. Hyperventilation will also cause a decrease in blood CO_2 levels which eventually causes a decrease in the organisms ability to buffer lactate.

It has been observed that there is a 5–10% reduction in VO_2 max when you first arrive at altitude. This reduction is related to the decreases in oxygen saturation of arterial blood and in cardiac minute output (CMO).

Cardiovascular Adaptations

Heart Rate

The increase in heart rate (bpm), both at rest and submax exercise, is due to the decrease in oxygen content in the blood. The heart has to pump at a greater rate to insure an adequate oxygen supply to the muscles. There is, however, a noticeable decrease of about 5–10 beats per minute during maximal exercise the first 10–20 days at altitude.

Stroke Volume

Stroke volume (ml) is defined as the amount of blood ejected by the left ventricle of the heart in a single beat. The stroke volume can be determined by factors such as total blood volume, heart size, and contractile force of the cardiac muscle. Altitude exposure produces a reduction in stroke volume during rest, sub-max and max exercise. This reduction is thought to be due to a reduction in blood volume.

Cardiac Output

The amount of blood that is pumped out of the heart in one minute is the product of heart rate and stroke volume (HR x SV). At altitude, the cardiac output increases both at rest and during submax exercise. However, it is reduced during max exercise. This reduction is due to a decreased stroke volume (SV) and heart

rate (HR). As a result of this phenomenon, a reduction in VO2 max is observed at altitude. Table 9.2 summarizes the cardiovascular responses at moderate altitude.

	Heart Rate	Stroke Volume	Cardiac Output
Rest	↑	↓	↓
Submax exercise	↑	↓	↑
Max exercise	↓	↓	↓

Table 9.2 Cardiovascular responses at moderate altitude.

Blood Chemistry

Plasma volume is the liquid portion of blood. It normally represents 55% of the total blood volume. When individuals are exposed to altitude, the blood volume has been shown to be reduced from 5% to 21% over a two week period. The percent of plasma reduction is dependent upon duration and intensity of exercise performed, as well as the balance between fluid intake and output. The greatest loss occurs through sweating and excretion of fluids. Fluids are also lost as a result of hyperventilation. This loss of plasma volume is the major cause of a decrease in stroke volume at altitude.

Hematocrit

Hematocrit (HCT) percentage is defined as the ratio of red blood cells to total blood volume. Normal values for a male is (42–52%) and for a female is (37–47%).

Hemoglobin

Hemoglobin (g/dl blood) is the molecule within the membrane of red blood cells that carries oxygen. An increase in both hematocrit and hemoglobin is referred to as hemoconcentration.

After a few days at altitude, hemoconcentration occurs as a result of a decrease in plasma volume. After a few more days at altitude, hemoconcentration is maintained as a result of increases in red blood cell production due to the hypoxic condition. It must be noted that red blood cell production will not occur unless a

sufficient amount of serum ferritin is present. Iron must be available before increased red blood cell production can take place. In order for erythrocythemia (RBC production) to take place, males and females must have at least <30ng/ml and <20 ng/ml of iron, respectively. This is the amount of iron present in the blood at all times.

Erythropoietin

Erythropoietin (EPO) is a hormone produced in the kidneys which is responsible for the stimulation of red blood cell production in the red bone marrow. Organisms have shown increases in EPO after a few hours of exposure to altitude. It has also been demonstrated that those elevated levels remain for as many as 10 days.

2, 3–DPG

The substance 2,3–DPG (2, 3–Diphosphoglycerate) is a compound produced within the red blood cells. It binds with hemoglobin. It's presence allows oxygen to be released more easily, thereby providing more oxygen to the muscles. There is a noticeable increase in red blood cell 2, 3–DPG upon exposure to altitude. As much as a 14% increase over a 14 day period at altitude has been observed.

Skeletal Muscle Adaptations

Oxidative Enzymes

Terrados, et. al. (1988) observed that when athletes are exposed to altitude there is a significant decrease in phosphofructokinase (PFK) and lactate dehydrogenase (LDH). These two enzymes are responsible for glycolytic activity. This activity is responsible for the production of energy without oxygen (anaerobic). At the same time, he reported greater free fatty acid utilization at altitude, as indicated by increased 3–hydroxy–CoA dehydrogenase (HADH) activity. These enzymatic adaptations suggest an improvement in the aerobic capacity with altitude training of four weeks at 2300 meters.

Capillary Density

Capillaries are the smallest units within the vascular system. Their function is the exchange of O_2, CO_2, nutrients and metabolic waste products between the blood and tissue. In theory, an increase in the number of capillaries per unit area (capillaries/mm^2), or the number of capillaries surrounding each muscle fiber

(capillaries/fiber), shows an increase in the oxygen uptake capacity of the muscle. It appears that training may increase both, but altitude has no effect on either.

Myoglobin

Myoglobin is the molecule responsible for oxygen transport within skeletal muscle tissue. Some research has suggested that altitude training will alter myoglobin concentrations. Terrados, et. al. (1990) reported that myoglobin concentrations increased by as much as 14% at altitude versus sea level conditions.

Lactate Buffering Capacity

The research has been inconclusive on whether there is an increase in the lactate buffering capacity. Some researchers report significant increases, and others report no increases at all. Until more work is done in this area, no conclusive statement can be made.

Competing at Altitude

The increases in energy cost of the oxygen transport at altitude, particularly at near maximal training intensities and during competition, remain a great handicap for athletic performance at altitude. Over the past thirty years of coaching at 2300 meters, this observation has become glaringly obvious. Its relative importance is proportional to the duration of the event.

With Adams State competitions, we were usually at altitude in the 1800 to 2400 meter range. We traveled south to Albuquerque, New Mexico, north to Denver and Boulder, Colorado, and Laramie, Wyoming, and west to Gunnison, Colorado. The performance times in the distance events from the 800 to the marathon were always noticeably slower. The longer the race distance, the greater the effect altitude had on performance times. The border line in this phenomenon seemed to be around efforts of 100 seconds. Distances shorter than 800 meters display a smaller hypoxic handicap that is largely out balanced by the lower air resistance, thus allowing for outstanding performances.

The 100 meter, 200 meter, and 400 meter races contested at 2300 meters were generally faster at altitude as evidenced by the world record times in these events in Mexico City. This has also been the case in the outstanding distances recorded in the throwing and jumping events while at altitude. The longer distances, over 100 seconds, however, have always been slower.

After studying the percent and time differences listed by event in Table 9.3. we find an occasional athlete with great adaptive mechanisms who will greatly exceed the percentage differences on the chart. But this is extremely rare. The results listed on Table 9.3 are of interest, not only as a practical confirmation of scientific considerations, but also as a base for optimal planning of training at altitude.

Event	Approximate Time Decrement	Time Difference Over Sea Level
800	- - - - - - - - -	- - - - - - - - -
1,500 (3:40)	.03.5%	7.7 seconds
3,000 (8:00)	.04%	19.2 "
5,000 (14:00)	.05%	42.0 "
10,000 (28:00)	.07%	118 "
Marathon (2 hrs. 20 min.)	.09%	756 " (12 minutes, 36 seconds)

TABLE 9.3 A comparison of the % decrement and approximate time (seconds) differential of those Olympic events over 800 meters.

There are two extremely important reasons to train at altitude:

1. The geophysical conditions at altitudes of 2000 - 2400 meters may be very favorable for training in sports based on speed and power.

2. The adaptive changes during training at altitude may prove useful for the endurance capacity in a normal sea level environment.

In as much as speed and power performances depend almost exclusively on anaerobic energy metabolism, there is no reason to expect physiological limitations due to hypoxia. Proper training methods and larger recovery times within the training sessions are necessary. Physical and biochemical advantages created by the lower air resistance and force of gravity at altitude, although small, contribute to enhanced performances (as demonstrated by the sprint and jump events in Mexico City).

Karvonen, et al. have presented experimental data to confirm the above statements and have concluded that:

"**Altitude training is equivalent to supramaximal training loads used for developing the neuromuscular system and anaerobic energy processes required for speed production. In a sea level environment, supramaximal sprints or horizontal jumps are practically impossible, unless incidentally, with a strong, fair wind, or surfaces with negative slopes. This, of course, is generally never found because track surfaces are level.**"

There are, however, special locations when an area has been prepared for a negative slope track, such as the practice track surface at the University of Oregon (Eugene). I have observed that, at altitude, the sprinter may run faster on a normal running track, preserving the conventional biomechanical structure of the motor activity (distance running or accelerating for jumping). This is hardly possible on a negative slope surface.

The second reason for altitude training is that adaptive changes occur while training at altitude (as a base for enhanced endurance capacity in normal sea level environments). Those changes have already been discussed.

The Controversies

It is the contention of some investigators, who have studied top level and highly trained athletes who are close to their individual maximum of trainability, that altitude might not further increase an already high capacity. As a matter of fact, they feel it might be dangerous to attempt an altitude sojourn.

There are also those investigators who feel altitude training is a powerful method for improving oxygen transport and endurance capacity, especially for highly trained athletes who are very close to the limits of their training programs in normal conditions. I have worked with and observed many top athletes who come to altitude for the last six to eight weeks of training prior to the top competition of the year. These athletes have then gone down to sea level and have run excellent races, sometimes resulting in personal bests. Lychatz, in his research, contends that altitude training may provide a way to enhance the physiological effect of exercise without further increasing the already very high volume of training loads on the musculoskeletal system.

The following are opinions of other top researchers in the field of altitude training:

1. Balke has stated that, following altitude training, the top athlete's physiologic capacity will be boosted and he/she should be able to utilize this advantage if called upon by adequate muscle action.

2. Jensen and Fisher in their review on altitude training have stated that there is no evidence that performance is improved by training at a higher altitude for performance at a lower altitude, with the possible exception that the anaerobic processes may be improved slightly by the high altitude training.

3. Saltin in 1986, after presenting experimental data, suggests that there are no favorable effects of training at altitude.

4. In contrast to Saltin's views, Nowacki (in 1988) presented very positive results from altitude training. He firmly believed that altitude training has great potential to improve the endurance performance of Olympic level athletes.

5. Lychatz in his review on the development of training methods in endurance sports during the cycle of 1985 - 1988 stated "In endurance sports, the hypoxia training is a key factor which may not be neglected. Otherwise, the world poll position will be lost."

6. Suslov, and others, have stated that the most probable reasons for the differences of opinion may be that there is a shortage of well established methods for endurance training of athletes to cope with the complexity of adaptation to the combined stress of hypoxia and vigorous exercise.

Individuals and teams who have positive experiences at altitude do so because they have a coach who understands the interrelationship between volume and intensity at altitude. Both coach and athlete understand the athlete's capacity and level of adaptation.

Having listed the problem of altitude, showing what the research has revealed and stating the opinions of those who have had experience with the various altitude problems, I would next like to focus on logistical and individual problems surrounding the athlete.

1. Because altitude is a stressor in itself, all other factors should be positive. The athlete should not have to worry about the following items:
   - Housing
   - Recreational opportunities
   - Accessibility to running areas
   - Tracks
   - Medical and therapeutic services
   - Ancillary workout areas

2. Attention to nutritional considerations:
   - Dining facilities
   - Micro nutrients
   - Additional fluid intakes

3. The athlete must understand that the better conditioned he/she is upon arrival at altitude, the more difficult it will be to elicit improvements.

4. A blood profile analysis must be administered periodically to determine if any problems exist. If there are existing problems, athletes definitely will not have a successful altitude experience.

5. Once at altitude, periodic blood profiling must continue to determine if the altitude or the training is having a negative effect on the athlete's metabolic or physiologic homeostasis (blood chemistry).

6. The athlete must not arrive at altitude with any existing medical or physical problems.

7. The willingness of the athlete to participate in the altitude experience is necessary. If athletes are not completely convinced that it will be good for them, then it will not be.

8. The athlete must be aware of possible difficulties they might encounter, such as:
   - Sleep disturbances
   - Headaches
   - Nose bleeds
   - Need for additional recovery time
   - Ultraviolet radiation

9. The athlete must understand at what altitude they will train and why they are training there.

10. The coach must take advantage of every opportunity to show athletes that the altitude is having a positive effect on them and their training protocol. This positive approach will assist the athlete's acclimatization.

11. The coach must understand and recognize the variability of individual athletes and develop an organized training program according to individual response.

I. Altitude Guidelines:

The research has shown, and coaches and administrators have recognized, that between 2000 and 2400 meters is the altitude where one can achieve optimal results. It is also recognized that repeated visits to altitude will facilitate the adaptation process. Both the athlete and the coach must recognize the objectives to be accomplished at altitude. These are listed below.

1. Is the athlete at altitude to enhance his/her general physical preparation (GPP) for the upcoming season?

   -or

2. Is the athlete at altitude to prepare for a key event (championships)?

Listed below are the three phases I have used successfully and have recommended to other athletes. If followed correctly, they will produce positive results.

Phase I: Acclimatization (7 days)

The first week at altitude the athlete must feel comfortable by performing non-specific exercises. Those include light running, swimming, cycling, weight training, circuitry and walking. The athlete who had been at altitude before should practice low aerobic running three times per day – A.M., midday, and P.M.

In almost all cases I have found that after a week of acclimatization, normal training is possible. I have also learned that the first week is when most athletes make mistakes by training too hard, making each ensuing week more difficult. Thus, little or no adaptation takes place.

I found that if individual athletes were allowed a higher degree of freedom in their workouts during the first week, they would adapt much better. During this first phase the athlete must be encouraged to hydrate as much as possible. This helps to eliminate the consequences of dehydration at altitude.

Strength training during the first phase can be maximized. These types of workouts are anaerobic and altitude will not have an effect on them. The first phase includes three developing, three regeneration and one light speed day with short sprints. Table 9.4 illustrates this.

Phase II: Training Phase (14 – 35 days)

The training phase will depend on the length of stay at altitude, generally two to five weeks or 14 to 35 days. Longer periods are usually better. The first objective to be accomplished during this training phase is to increase the athlete's volume towards maximum. This is generally accomplished during the second week at altitude. Figure 9.3 illustrates this.

The second objective is a systematic intensification of the workout. (See Table 9.3.) The goal is to run with close to the same intensity at altitude that one would run at sea level. Many experts in altitude training say this is not possible, but, one works towards this goal. The ability of adaptation always determines how close to maximum intensity the athlete can achieve.

Duration (days)	First Phase: Acclimatization	Second Phase: Regeneration
Endurance Run (ER) (Training Sessions)		
A) Intensive ER	- - -	
B) Developing ER	3	3
C) Regeneration ER	3	3
Endurance Runs with Changing Speed	- - -	1
Speed Runs		
Long (> 1000 m)	- - -	1
	- or -	
Short (< 1000 m)	- - -	1
Speed (< 60 m)	1	1
Other activities (e.g. walking, etc.)	1	- - -
Massage	1	2

TABLE 9.4 Different types of activity during the first and second training phases of acclimatization.

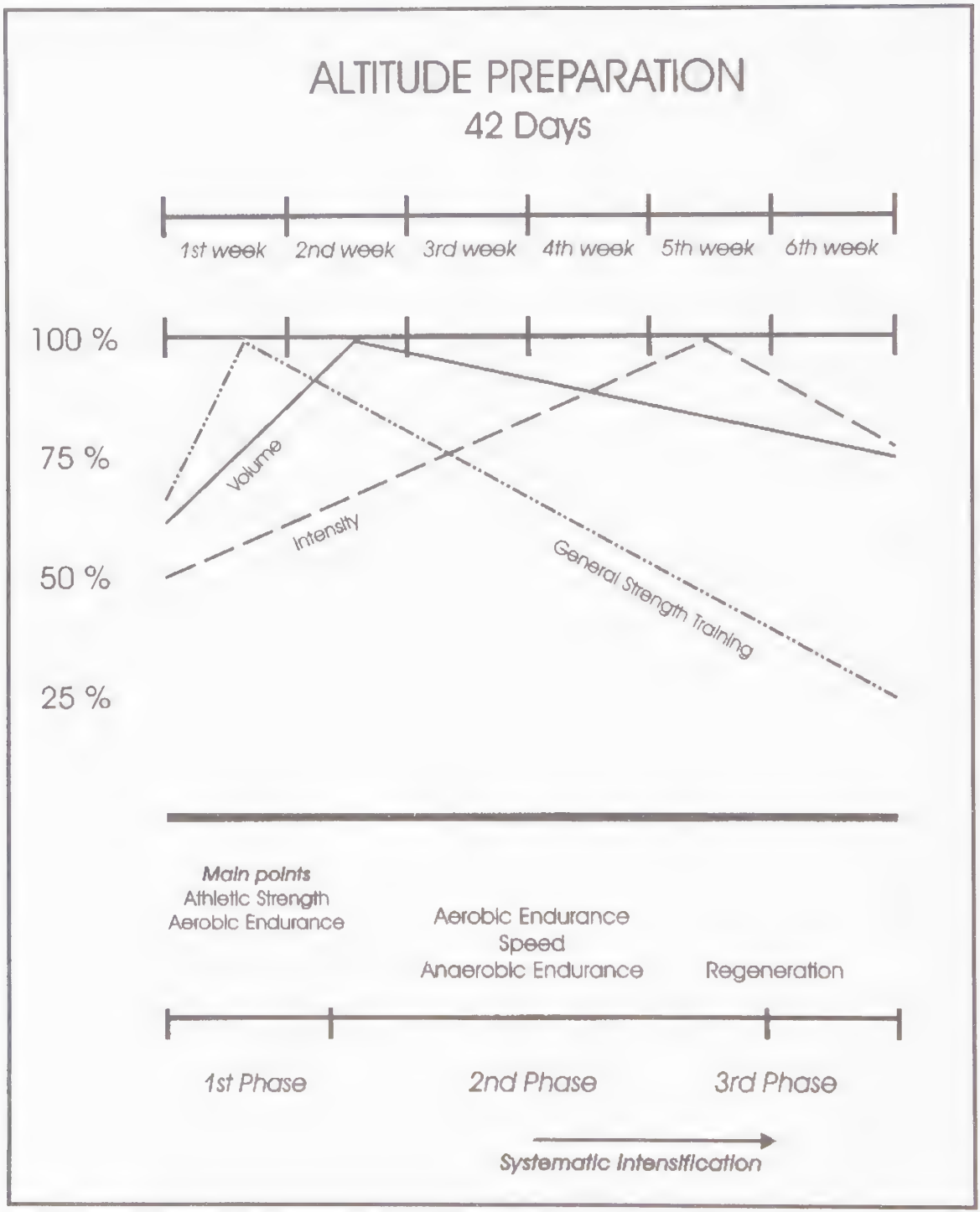


FIGURE 9.3 Selected factors of altitude training using a six week period at altitude.

The second phase includes three developing endurance runs each week with intensification increasing each week. Increases in intensity must be slowly progressive. Three regeneration runs to recover from the developing runs must be included. The third type of workout is an endurance run with changing speed. This resembles a Fartlek run.

Included in Phase II is one session per week of longer (> 1000 meter) runs and one session of shorter (< 1000 meter) runs. If the athlete's stay at altitude is to be longer than three weeks, the third, fourth and fifth week may include two speed runs per week, or two long and one short run.

The guide for reduction of intensity when going from sea level to altitude is illustrated in Table 9.5.

Careful planning must be undertaken at all times to protect against overtraining. Make every effort to properly distribute the training and recovery loads. The coach must always make subjective observations.

Distance	*Time Reduction*
200 meters	0.5 - 1 second faster
400 meters	the same as at sea level
800 meters	2 - 3 seconds slower
1000 meters	4 - 6 seconds slower
One mile	7 - 9 seconds slower
2000 meters	25 - 30 seconds slower

TABLE 9.5 The relationship between training distance and time reduction at altitude.

Phase III: Regeneration (7 Days)

The regeneration phase is a week long microcycle where the athlete regenerates before returning to sea level. The most important considerations are:

1. To avoid the stress and fatigue encountered at altitude before returning to sea level.

2. Observe the third phase workouts in Figure 9.3. There is a noticeable decrease in volume, intensity, and general strength training.

3. If altitude training is done correctly, it will be as effective as a considerably longer training phase at sea level. It doesn't make any difference if the athlete's stay at altitude is three weeks or six weeks.

4. The longer the stay, the greater the adaptation through six to eight weeks. Physiologic changes can occur with the shorter time period.

5. Readaptation to altitude becomes easier with one's second, third and fourth trips over a period of a year or several years. The athlete copes better with each trip.

Upon returning to sea level, readaptation is critical because the athletes are either going to compete and return to altitude, or they are going to resume sea level training. Bishon makes the following recommendations for athletes who are going to compete:

1. The athlete can compete during the first three to ten hours immediately after returning to sea level.

2. The athlete can compete after the fourth or fifth day upon returning to sea level.

3. The athlete can compete between the 12th and 30th days after returning from altitude. (This plan has been used more often with greater success than plans 1 or 2.)

Training Guidelines

Consequences of the altitude environment for sport training may be summarized as follows:

1. Altitude does not interfere with short term exercises, depending mainly on anaerobic energy supply. The motor system may be optimally stressed during activities shorter than 100 seconds.
2. The racing speed in track events longer than 100 seconds depending predominantly on aerobic power and endurance may be 1% to 8% slower than at sea level. The longer the distance, the greater the difference. The motor system may not be stressed optimally because work rate is limited by the reduced oxygen supply resulting in general strain rather than in muscle power or muscle oxidative capacity.
3. Recovery time after intensive training loads may be slightly longer at higher altitude.
4. The most vulnerable period during altitude training is generally the phase of acclimatization when self control, based on feedback information, may be disturbed and the psychological strain of training may be underestimated.
5. After returning from altitude, several days are needed for reacclimatization and readjustment.

Based on these considerations, the following guidelines may be useful in altitude training for performance in normal environment.

1. Speed and power training may not create any problems. Training schedules performed at sea level may be almost identical to those used at altitude. An important recommendation is to use slightly longer recovery intervals.
2. When work intervals are longer than one minute, the number of repetitions should be reduced, but the speed should be held at the highest possible level for the training distance.
3. The optimization of endurance training is more complicated because the habitual pace of running is impossible due to hypoxia.

Long distance running may be run with a speed .3 – .4 meter/sec. slower than at sea level.

The expected handicaps are:

2 to 2.5 minutes for 10 k
50 seconds for 5 k
10 - 15 seconds for 2 k
4 to 8 seconds for 1 k

4. As much as possible, avoid training at the competition distance. Run fractions of the competitive distances as fast or faster pace than when running the whole distance at sea level.

5. The structure of training has to be arranged on an individual basis according to the annual training plans. Generally, the workouts have to be shorter in the earlier stages, the number of repetitions reduced and the recovery time prolonged.

6. A marathon runner should be able to run 12 – 15 km at sea level pace for the marathon distance. A 10,000 meter runner should be able to run at 3–5 km at a speed comparable to sea level pace.

"Nobody should be able to break you in a race. Most races are won in the last mile. If you are up there with a mile to go, it is mental courage that prevails."

Coach Joe Vigil at training meeting

Study Guide

1. What problems are encountered when training or competing at altitude?

2. Differentiate between barometric pressure and partial pressure of oxygen.

3. What are the reasons for training at altitude?

4. List the systemic adaptations that can happen when proper training at altitude occurs.

5. How much does altitude affect the various track distances?

6. What training guidelines must be considered when attempting an altitude sojourn?

7. What preparations should be considered prior to altitude training?

8. What is the relationship between altitude training and distance running success?

II. Organismic Responses to Living and Training in Hot Environments:

Many track and field competitions are contested in hot and humid environments. The conditions found in these areas range from 60 to 90 degrees Fahrenheit, with average relative humidities of 60% to 90%. In these temperatures, it is imperative that coaches and athletes understand the effects on athletic performance.

Each location and each event involves a mixture of exercise intensities, exposure to heat, and ability to ingest liquids. Coaches must develop a plan of acclimatization and training for their athletes which is specific to the location in which they will perform.

This section of training in exotic environments will attempt to answer many of the questions about training and performing in hot and humid weather. It will present information on the detrimental effects of heat, humidity and dehydration as well as acclimatization protocols.

A. Organismic Responses to a Hot Environment

Distance runners never have the luxury of performing in indoor, air conditioned arenas where heat and humidity are controlled. Basketball, boxing, wrestling and gymnastics athletes have the advantage of performances in climate controlled environments.

The body's internal, or core, temperature is 98.6 degrees Fahrenheit. It is not difficult to maintain this temperature during low intensity activities by balancing heat loss with heat production. At the same time, living in dormitories without air conditioning in high temperature regions can cause up to eight to ten liters of dehydration on a daily basis. Other problems, such as moderate exercise found in recreational activities, or exposure to direct sunlight for several hours a day, can also lead to unnoticed dehydration problems.

The above problems, together with participation of strenuous activities involved in daily practice, can lead to heat production that supposes heat dissipation. As a result, the body's core temperature will increase. This condition is called hyperthermia. The consequences can lead to decreased physical performances

and possibly to potentially harmful conditions such as heat stroke (if the core body temperature exceeds 103 to 106 degrees Fahrenheit).

Sawka and Wenger in their work on "Human Performances of Terrestrial Extremes" illustrate quite vividly the difference between two athletes and their ability to dissipate heat (Figure 9.5). The differences between athlete A and athlete B may be due to several factors, such as training in hot environments, body weight, percent body fat, duration and intensity of training, and whether the athletes are indigenous residents of a hot climate environment. Certainly exposure to or acclimatization to a hotter environment will allow the athlete to respond like athlete B in Figure 9.5.

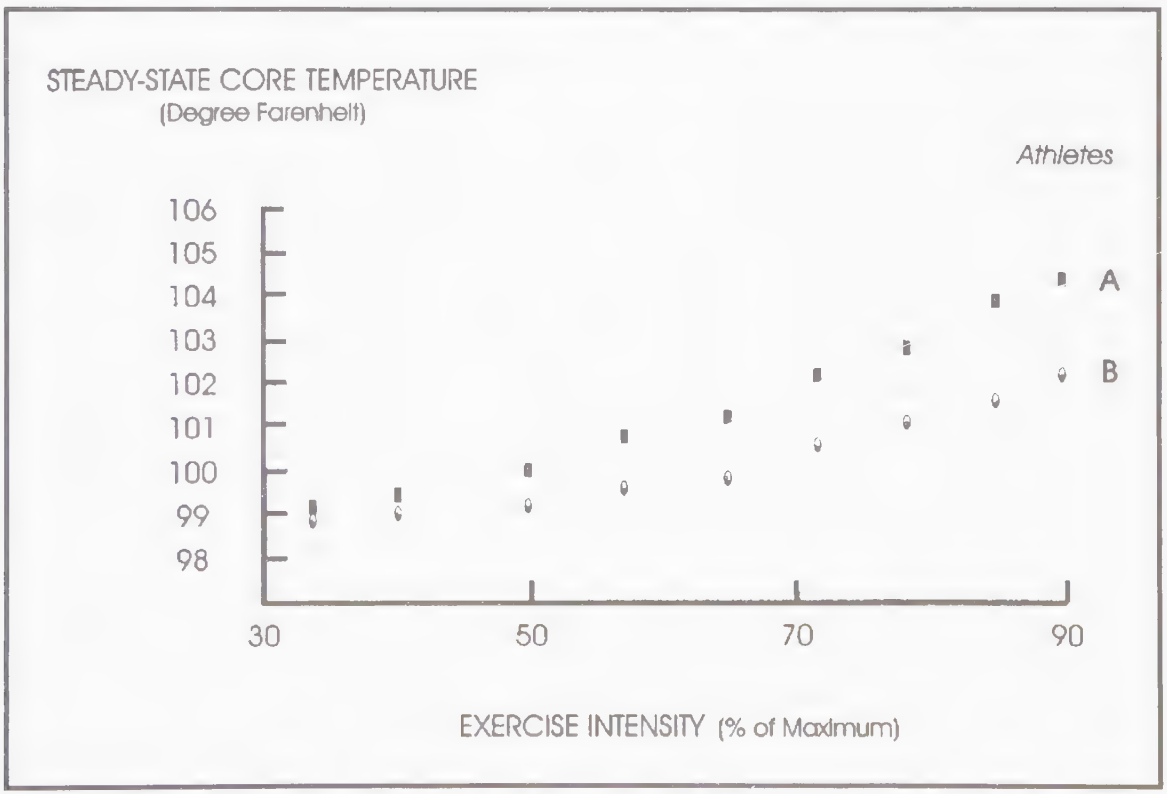


FIGURE 9.5 A comparison of two athletes exercising at similar intensities and producing different core temperatures.

Another factor which must be strongly considered is the training intensity in relation to steady-state core temperature and ambient temperature. Figure 9.6 clearly indicates that ambient temperature and exercise intensity are combined to increase the core body temperature. Note the differences produced by performing at three differing intensities in Figure 9.6.

It has been observed that core temperatures can reach 100 to 105 degrees Fahrenheit in distance runners who perform in hot weather without causing any apparent harm. This condition is somewhat controlled because these athletes learn to properly hydrate during the activity. They also learn to ignore the discomfort produced by hyperthermia. Experiences in exercise intensity and hot temperatures can produce heat stroke and one must protect against it.

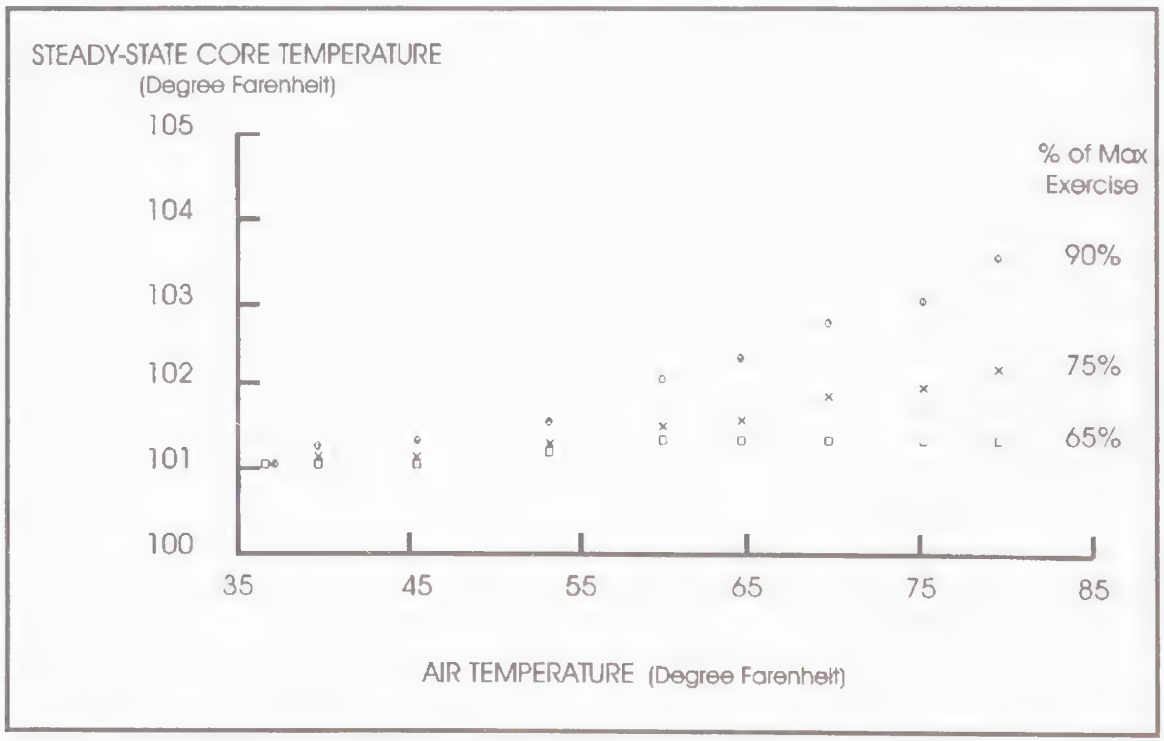


FIGURE 9.6 The relationship between air temperature, intensity of exercise and increase in core temperature.

B. The effects of Heat on Strength and Endurance

Adams, et al. has suggested that hot ambient environments – those which cause hyperthermia – might cause a decrease in physical performance in three different ways.

1. The research has concluded that development of strength or generation of force is relatively unaffected by increases in muscle core temperature. Athletes understand the importance of the warm-up. Excessive warm-up can develop the onset of hyperthermia if the environmental temperature is excessive. It is extremely important for the athlete to understand that hyperthermia causes a reduction of muscle endurance, or the ability of prolonged muscular contractions. This condition can certainly have an affect on performance, particularly the endurance sports.

2. The caloric nutrients, fats, carbohydrates and protein are eventually metabolized and stored in the form of energy rich components called adenosine triphosphate (ATP). This compound is responsible for the contraction and the normal function of the muscle cells. Chapter Two described how ATP can be produced two different ways, aerobic metabolism, with oxygen, or anaerobic metabolism, without oxygen. Intensity, duration of exercise, and physical condition of the athlete will determine the contribution's of anaerobic and aerobic sources of ATP. The body shifts to anaerobic energy production under hyperthermic conditions. Under these conditions, carbohydrate stores (glycogen) will be utilized at a much faster rate. This is the primary reason why athletes performing in cool environments produce much better results.

3. Performing in hot environments clearly imposes a stress on the cardio-vascular system and affects the endurance capacity. Hyperthermia causes (1) the dilation of skin blood vessels and the pooling of blood in the appendages, (2) increased heart rate, (3) decreased muscular blood flow, and (4) reduced cardiac output. All of these mechanisms result in circulation strain and produce the onset of fatigue. This inability to deliver sufficient oxygen to the muscles will not allow the athlete to maintain intense, high speed running. The above scenario forces the athlete to rely more on anaerobic mechanisms for ATP production, thus increasing the utilization of carbohydrate stores. The consequences of this condition will have a negative impact on endurance events.

C. The Effects of Humidity

The evaporation of sweat accounts for 80-90% of body heat loss while exercising in a hot-dry environment. The body's attempts to lose heat in a hot-humid environment, however, are less efficient. The organism attempts to eliminate internal heat by maximizing blood flow to the skin. In Figure 9.7, Armstrong clearly indicates the relationship between steady state core temperature, air temperature, and increases in humidity. It can be observed that core temperature will increase as the athlete exercises under the conditions stated. Blood pressure and cardiac output will decrease more in a hot-humid environment. These consequences will lead to a reduction in endurance and more rapid onset of fatigue.

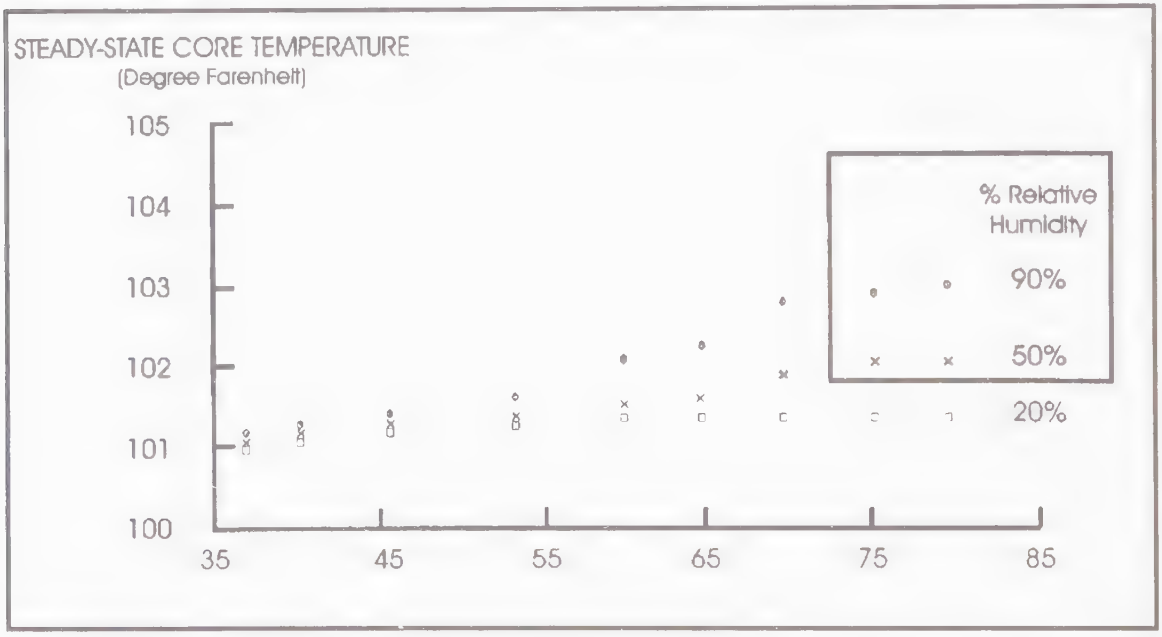


FIGURE 9.7 The effect that ambient air temperature, in combination with percent relative humidity, has on core temperature.

"Acclimatization to heat and humidity is as essential as acclimatization to altitude in order to obtain optimal performance."

– Coach Joe Vigil

D. Organismic Responses to Dehydration

Exercising athletes stimulate the production of sweat even in cool temperatures. The amount of fluid lost depends on how the athlete is clothed, the intensity and duration of the exercise, and the environmental conditions. During intense exercise, athletes can lose one to two liters of sweat per hour. During nonathletic activities, one to ten liters can be lost during each 24 hour period.

It is apparent that when sweat and urine losses exceed fluid intake, the athlete will experience a water deficit. Therefore, all athletes must develop a plan for monitoring body water status each day. The best strategy involves drinking a volume of liquid equal to sweat loss. Coyle, in his research, has estimated that the maximum amount of fluid that empties from the stomach during activity is 0.8–1.3 quarts per hour. It is therefore essential that this amount should be taken in before, during, and after activity. It is important to remember to hydrate in preparation for training as well as for competition.

In events lasting more than 30 minutes, where dehydration continually progresses, noticeable cardiovascular strain will become apparent. Under this condition, blood volume, skin blood flow and sweat rate all decrease and tend to produce the onset of hyperthermia in a state of dehydration. All endurance athletes must be concerned with dehydration. Body water losses of two to four percent of body weight will result in reduced VO_2 max in both mild and hot environments. In addition, the capacity for cardiovascular endurance exercise is reduced.

E. Dehydration Rehydration Cycles

It takes three to four hours for the fluids in all of the body's tissues to equilibrate after water has been removed from the body. Dehydration is of real concern to all athletes because circulatory, and then intramuscular liquid balances, are affected. Dehydration has a real effect on athletic performances, particularly those activities that require cardiovascular endurance.

The consequences of dehydration can occur under two conditions:

1. Well hydrated athletes can become dehydrated several hours before the competition. In this situation, the athlete will experience loss of fluid from the circulatory system. The cardiovascular system will then be unable to meet the demands of the activity.

2. In the second scenario, the athlete dehydrates during competition. Water losses can take place up to 5% or more of body weight with very little reduction in blood volume. Hydration during exercise has little effect on fluid losses from circulation. It will, however, delay the onset of hyperthermia. It is always wise to rehydrate prior to competition, especially when dehydration has occurred several hours prior to competition. A small percentage of the cardiovascular function can be restored in spite of large water losses. The athlete can expect large urine loss during the rehydration period. Fluid balance is generally not met, even after one has had three to five hours of hydration prior to competition. The magnitude of dehydration is always the determinant.

Costill, et al. recommend the following steps to replace fluids during endurance exercise:

1. Drink 16 ounces of fluid 120 minutes prior to exercise.
2. Drink as early as 15 minutes into the exercise.
3. Drink small volumes, four to seven ounces, to avoid gastric discomfort.
4. If the stomach feels bloated or full, do not drink more water.
5. The athlete should attempt to maintain a comfortable stomach fullness.
6. Electrolyte supplementation may be required during prolonged events.
7. Evaluate and pretest all strategies for rehydration prior to competition.

F. Effects of Long Term Exposure to Hot–Humid Conditions

It must be remembered that exposure to hot-humid environments for many hours may result in negative consequences while training or competing. Gradual dehydration can result in heat illness and the onset of mood changes. These changes are subtle and take several hours to develop.

The heat illness conditions are as follows:

1. Heat cramps can be prevented by consuming adequate salt and water in the diet. Heat cramps are generally caused by electrolytic and fluid imbalances in muscle tissue.
2. Heat syncope is likely to occur when individuals stand in heat for extended periods of time without any movement.
3. Heat exhaustion can be caused by fluid or electrolyte depletion. Under this condition, the athlete cannot continue to exercise. Depletion can be reversed by replacement of minerals and fluids.

All three conditions can be prevented with proper heat acclimatization, diet and hydration.

G. Monitoring Body Water Status

An average sized athlete of 150 pounds gains and loses 2.4 quarts of water daily in a favorable environment. Urine accounts for the majority of liquid loss. In addition, water is lost through the feces, respiration, and through the skin. In hot-humid environments, sweat accounts for the majority of the liquid loss. In extreme conditions, as much as ten quarts of liquid loss has been observed in some athletes. It is therefore necessary for athletes to know their sweat rate during training and competition. The following steps should be taken to better understand this liquid loss phenomenon.

1. Measure body weight before and after exercise and know the difference.
2. Exercise for one hour at a typical training or competitive intensity.
3. Measure body weight in the nude.
4. Fluid consumed should be added to the difference in weight loss in pre and post weights in Item 1.
5. Urine loss during exercise should be subtracted from factor in Item 1.
6. After correction in Items 4 and 5 have been made, subtract sweat losses pre–exercise body weight minus post–exercise body weight.
7. Water losses should be replaced by consuming eight ounces of fluid loss for each pound of body weight lost.

Example:

Body Weight – Pre-exercise	–	150 lbs.
Body Weight – Post-exercise	–	147 lbs.
(Body Weight – Taken in the nude)		
Fluid consumed during exercise	–	.5 lbs.
Urine lost during exercise	–	.2 lbs.

150 – 147	=	3 lbs.
+ sweat rate of .5 lbs.	=	3.5 lbs.
urine loss of .2 lbs	=	3.3 lbs.

Water replaced Item 7 above =26.4 ounces

It is always unwise to begin an exercise session with a weight deficit that started the previous day, especially if competition occurs on consecutive days. Accurate body weight measurements taken at the same time daily will allow the athlete to identify water deficits. Once this has been determined, steps to replace the water deficit at the rate of eight ounces per pound of body weight loss should be undertaken.

While training in hot-humid environments, if body weight losses by dehydration cannot be replaced on a daily basis, efforts should be made to reduce the intensity and duration of the workouts until liquid loss equilibrium can be achieved.

General observations to be made are:

1. Average daily urine loss = 1.2 quarts.
2. Less than this indicates that the body is trying to conserve water, thus the athlete should consume more liquids.
3. Urine which is dark yellow in color and scanty indicates dehydration.
4. Vitamin C can contribute to the yellow color of urine.
5. Urine should be straw–colored and plentiful.

H. Ergogenic Drinks

For the past 30 years two questions have been asked about ergogenic drinks:

1. *Should athletes drink water or drink a sugar electrolyte during exercise?*

   Water is the most widely used liquid during exercise. However, there are three exceptions to the use of pure water as the rehydration agent.

   a. In endurance events of longer than 60 minutes, the athlete will benefit from ingesting diluted carbohydrate drinks (5–8%), thus delaying the onset of exhaustion.

   b. In ultra-endurance events, athletes may experience dilution of their blood and extracellular fluid (hyponatremia). If sweat losses are considerable and they are replaced by water only, concentrated fluids should be used to reach original balances.

   c. The research has shown that, after exercise, sugar-electrolytic liquids replace fluids in the bloodstream much faster than pure water.

2. *What ingredients must a replacement fluid contain?*

   If an athlete does not experience large fluid losses, ingesting water will be sufficient to maintain normal body fluid balance. If, however, large liquid losses are experienced, there are several points to consider. The ideal fluid replacement beverage should empty rapidly from the stomach and should maximize absorption of fluid from the intestine into the bloodstream. Glucose and the electrolytes (sodium potassium and chloride) should be in solution in all replacement fluids. Different events and environmental conditions dictate the requirements to be considered, as well as duration, frequency and intensity of exercise. It is necessary for the athlete and coach to discuss the above recommendations and to properly implement them.

I. Heat Acclimatization Guidelines

Armstrong, et al. have outlined the recommendations all athletes should follow in trying to adapt to heat and humidity. In addition to the following recommendations, it is extremely important for the athlete to closely observe the criteria set forth in Section G.

1. Heat acclimatization can be facilitated by exercising in heat at intensities greater than 50% of VO_2 max. The exercise intensity and exposure time should gradually be increased during the first 14 days of hot weather training.

2. There are individual differences in the onset and delay of heat acclimatization. These differences usually result from cardiovascular differences between athletes. Those with high VO_2 max will reach stability in heat acclimatization much faster than those with lower VO_2 max. The losses in heat acclimatization will also he slower.

3. Heat acclimatization may be induced by wearing insulated clothing in a temperate environment. The athlete must not in any way inhibit heat dissipation.

4. Once heat acclimatization has been achieved, there will be day to day variations in heat tolerance experience. Some of these factors are infectious diseases, sleep loss, substrate depletion of glycogen or glucose, medications and increases in training intensity. These conditions can bring on the risk of heat illness.

5. Because there are always possibilities of heat exhaustion and hyperthermia occurring as exercises increase in intensity, athletes must always place an emphasis on the prevention of heat illness. Careful considerations must be placed on environmental conditions, proper clothing, consumption of liquids and electrolytes, recognition of warning signals of heat illness, and on exercising with a training partner.

6. When moving from a cool to a hot climate, the athlete may find it difficult to repeat workouts which they performed in the cooler, less humid environments. It is always wise to conduct the most intense activities in the cooler mornings of the hot-humid environments than in the heat of the day. Then one should gradually adapt to the heat of the day.

Study Guide

1. Why must the athlete always be aware of the heat and humidity at the time of workouts.

2. What are the major causes of and consequences of hyperthermia?

3. How does heat affect strength and endurance?

4 How does humidity affect strength and endurance?

5. How does the body respond to hydration and rehydration?

6. How does one monitor the body's water status?

7. What are the advantages and disadvantages of electrolytic drinks?

8. Know and understand the guidelines of heat acclimatization .

III. EFFECTS OF COLD ENVIRONMENTS

All athletes performing in cold climates must be aware of (A) adaptation to the cold weather, (B) disturbances that might occur which will affect performance, and (C) dangerous situations that may arise during exercise. It is also a well known fact that continued exposure to cold environments results in greater ability to withstand cold. Perhaps the most important factor is the maintenance of core temperature (rectal temperature which reflects CNS and internal organ temperature).

A. Adaptations

As the body reacts to cold, there is a reduction of heat loss which is met by an increase in metabolism. As a resting, naked person is cooled from a comfortable 85 degrees Fahrenheit to 72 degrees Fahrenheit, there is no increase in metabolism. The heat is conserved by vasoconstriction of cutaneous blood vessels which prevents the loss of heat carried by the blood from the core. As the temperature drops below 72 degrees Fahrenheit, the body's metabolism is increased by shivering. This involuntary increase in muscle contractions may raise the body's metabolism 2 – 4 times the resting rate. This mechanism can best be described by the following diagrams:

Effects of cold to the whole body

Circulation

- peripheral circular resistance ↑
- peripheral & skin circulation ↓
- work of the heart ↑

Metabolism

- energy metabolism ↑
- oxygen consumption ↑
- sympathoadrenal activity ↑
  = stress

Performance Capacity Falls ↓

Local cold effects in the body

Neuromuscular Function

- muscle power ↓
- muscle speed ↓
- coordination ↓
- injury risks ↑
- frostbite risk ↑

Local metabolism ↓

Tissue temperature ↓

As one begins to adapt to cold climates, there is a noticeable increase in blood volume. At the same time, there is a decrease in hyperventilation and sympathoadrenal responses (less stress). The initial rise in basal metabolism begins to decrease as there is a balancing of body temperature. At the same time, peripheral and circulatory resistance decreases.

B. Disturbances

All of the metabolic disturbances initiated by cold weather training can be adapted to within reason. Of great importance is the realization that ample, suitable clothing must be worn by the athlete at all times. Another factor to consider is that adaptation to cold is composed of psychological as well as physiological factors. It is the interaction between the two which ultimately determines how well and how quickly one adapts. The adaptation process varies from individual to individual.

Body build and fat tissue ratio are important factors in one's ability to withstand cold. Endomorphs (rotund individuals) have less surface area in relation to volume or body mass. Consequently, there is less heat loss than in ectomorphs (angular bodies) or mesomorphs (muscular bodies). The last factor to consider is that round, fat persons are better able to withstand cold because their fat tissue is an excellent insulator against heat loss.

Berg, et al. have stated that, as core temperatures during exercise fall below normal endurance, VO_2 max and heart rate will all decrease linearly with decreasing body temperature. There is approximately a 5–6% drop in VO_2 max with each degree decline in core temperature. At the same time there is a decrease in heart rate, approximately 8 beats per minute per degree centigrade. One can easily see that there are many disturbances when one is exposed to training and competing in cold weather.

C. Dangerous Situations

Ability to withstand cold environments varies widely with individuals, and remarkable resistance to cold has been claimed by some religious groups using yoga and hypnosis. In all cases, resistance to cold depends on elevated metabolism.

Table 9.5 shows the combined effect of wind and temperature, or the wind chill factor, as it is called. It can be seen that a temperature of -20 degrees Fahrenheit with no wind is not likely to cause tissue damage (frostbite) for a properly clothed

individual. There is, however, danger of freezing exposed flesh at the same temperature if the wind is blowing 20 – 40 miles per hour. The danger is even greater with higher winds.

WIND SPEED MPH	Thermometer readings (degrees Fahrenheit) and its actual temperature effect on exposed flesh.											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
40	26	10	-6	-21	-37	-53	-64	-85	-100	-116	-132	-148
	Little danger if properly clothed				Danger of freezing exposed flesh			Great danger of freezing exposed flesh				

TABLE 9.5 The combined effect of wind and temperature. (wind chill factor)

Vigorous exercise can balance the wind chill factor by metabolic heat production. This balancing effect requires a tenfold increase (10 mets) over resting metabolism to maintain thermal balance if the temperature is approximately –20 degrees Fahrenheit with a wind velocity of 9 miles per hour. In conclusion, adaptation to exercising in cold environments is possible, but it is equally important to be clothed properly while exercising in extremely cold, windy conditions.

Study Guide

1. What are the acute and chronic adaptations to cold weather?

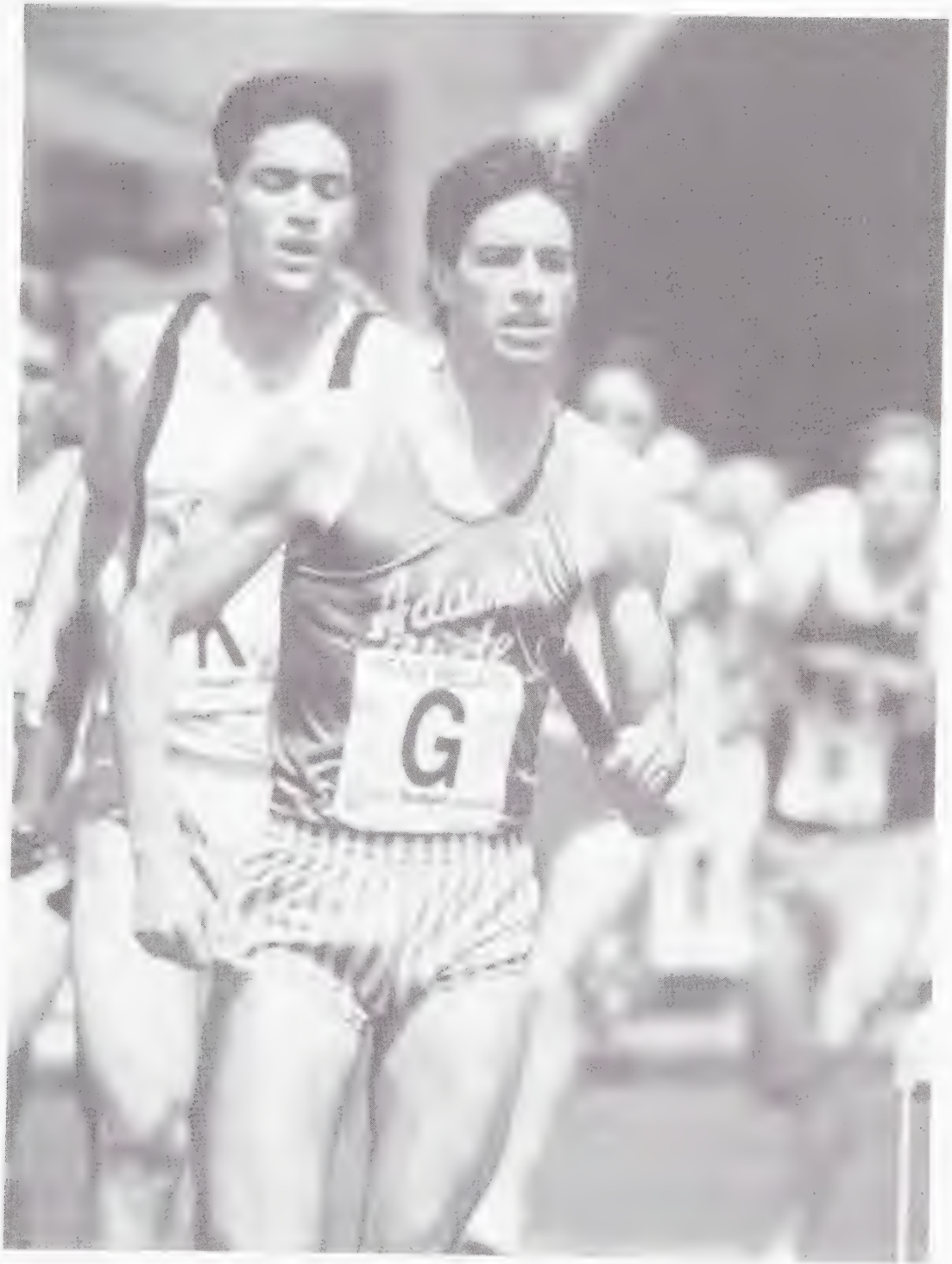
2. What disturbances are there while exercising and competing in cold weather?

3. What are the dangers involved in cold weather activity?

4. Under what conditions is adaptation possible?

5. What is the wind chill factor index?

6. What are the concepts involved in wearing proper clothing and what are the dangers if improperly clothed?



Dan Maas anchoring the 4 X 1,500 relay at the Penn relays.

Peter Grahm showing great form as he wins the 1,500 meter National Championship for Adams State in 1983.

10 Ancillary Training

"No one ever attains very eminent success by simply doing what is required of them: It is the amount and excellence of what is over and above the required that determines the greatness of ultimate distinction."

Charles Kendall Adams

Overview

Ancillary training includes flexibility, power and strength drills needed to facilitate successful middle distance running. Standards in each area are presented along with illustrations, programs and periodization. The higher the degree in power, flexibility and strength, the better a runner can execute motor movements.

Introduction:

In today's society, there is a noticeable lack of fitness in the general public as well as in athletes. There are many reasons for this condition. Physical education programs offered in the private and public schools of America are not sufficient or of the quality that will produce desired fitness levels. The number of labor saving devices and lack of movement in young children is producing a society of hypokinetic individuals with many problems as a result of underactivity.

Fitness might be defined as a degree of adaptation to the many stressors of a given life-style. In addition to the fitness required to tolerate the stressors of day-to-day living, athletes must acquire a fitness specific to the athletic demands of their respective events. The demands of athletic events are very diverse, so also are the

day-to-day lives of the athletes. If the athlete is unfit for life outside athletics due to inability to adapt to its stressors, then there will be an overlap into his or her athletic event and to the capacity for developing athletic fitness. One of the most important roles a coach or athlete must understand is the management of the athlete's life both in and out of athletics. This quality is of paramount importance in the pursuit of athletics fitness and fitness in general.

All athletes, male or female, must develop a sound basis of general strength, strength endurance and mobility before being introduced into technique. The best age for learning technique and developing speed and joint activities is 8 to 11 for girls and 8 to 13 for boys. All fitness training should be introduced progressively. The increases in mobility, strength, speed and endurance throughout their lives will help athletes advance from junior to elite to world class level.

In order to improve athletic performance or competitive advantage, it is necessary to include a pattern of technical training which has to do with the specific demands of one's athletic event. Secondly, a pattern of conditioning training (ancillary activity) must be included: this includes strength, plyometrics and flexibility training. Each of these will be treated individually as follows:

Strength Training:

1. **Maximum Strength:** The greatest amount of force that can be exerted in one maximum voluntary contraction. One quickly realizes that this will involve neither speed nor endurance factors. It is not necessary for middle or distance runners to acquire maximum strength. Table 10.1, Procedure 1, by Harre will describe the required procedure in strength training to acquire maximum strength.

2. **Elastic Strength:** This is one of the most important forms of ancillary strength training. It includes the development of strength where both the contractile and elastic components are assisted by reflex contraction as an expression of speed strength. Many believe that it is relevant to explosive type events such as sprinting, hurdling, jumping and throwing. I believe that middle distance runners can benefit enormously from this type of training. Average distance runners can also acquire substantial benefits. See Table 10.1 procedures 2, 3 and 4 for development using weights. The section on plyometrics will address elastic strength development in greater detail.

Pro-cedure	Additional weight (% of maximum strength	Repetitions per series	Motor velocity	Interval	Number of series per session and exercise	Organ-izational-methodical procedure	Application
1	100% - 80%	1-5	continuously	2-5 minutes	beginners 3-5	stationary tr., e.g.: 80% 95% 5X + 2-3X + 100% 95% 1X + 1-3X etc.	To improve immediately max. strength in a-cyclic events with high demand on this capacity
2	85% - 70%	5-10	continuously to slow	2-4 minutes	3-5	stationary tr. 70% 80% 10X + 7X + 85% 85% 5X + 5X etc.	As above, but for events with cyclic movements; supplement to power & strength endurance training
3	60% - 70%	6-10	very fast	2-5 minutes	4-6	stationary tr. 70% 70% 10X + 10X + 70% 10X etc.	To improve immediately power & maximum strength, at same time
4	50% - 30%	6-10 at max motor velocity	explosively	2-5 minutes	4-6	stationary tr. 30% 40% 10X + 10X + 50% 40% 10X + 10X	To improve immediately power at well developed max strength
5	60% - 40%	50%-75% of the max	fast to continuously	30-45 sec.	3-5	circuit training	To improve strength endurance in events that put high demands on this capacity
6	40% - 25%	25%-50% of the max	continuously to fast	optimally	4-6	stationary or circuit train.	To improve strength endurance –events with low demands

Table 10.1 The role of maximum strength in various track & field events. Harre.

3. **Strength Endurance:** This type of training is used primarily in events where lactic anaerobic endurance is involved and a high number of repetitions are required. It is necessary for all athletes to develop a basic level of strength endurance, but, endurance athletes must incorporate this type of strength training to a greater extent in their ancillary training. Table 10.1, procedures 5 & 6 describes what is necessary.

4. **Absolute Strength:** This is the athlete's maximum strength regardless of his or her body weight. Thus the absolute strength of the hammer thrower in Table 10.2 is greater than that of the long jumper or 800 meter runner. Maximum strength comparisons for various events can be compared in Figure 10.1.

5. **Relative Strength:** This is the athlete's maximum strength relative to his or her body weight. In Table 10.2 the hammer thrower strength is greater than that of the long jumper or 800 meter runner.

6. **Dynamic Strength:** This is the type of strength required for those joint actions where there is a movement in a given athletic technique. This type of movement is divided in overcoming concentric strength and yielding eccentric strength. An example may be where the concentric strength is required across the hip and knee joint in raising the weight in a squat exercise, while eccentric strength is required in the controlled lowering of the weight.

Athlete	Body Weight	Dead Lift	Dead Lift / Body Weight
Male Hammer Thrower	110 Kg	350 Kg	3.18
Male Long Jumper	80 Kg	220 Kg	2.75
Male 800 Meter Runner	72 Kg	195 Kg	2.70

TABLE 10.2 Absolute vs. Relative Strength of three selected athletes.

Loading used for the development of dynamic strength will vary according to the requirements for maximum, elastic or endurance strength, and the need for absolute, or relative strength. The development of dynamic strength should be developed by the dynamic method, with appropriate movement, and not by static methods. This will be addressed in the section on plyometrics.

In comparing static to dynamic strength, Figure 10.2 demonstrates the dynamics of forces of athletic movements as separated in the internal and external force. The internal force represents the athlete's capacity to develop internal strength. The external forces acting on the body in athletic movement (e.g. the individual's gravity, additional resistance such as barbells, disks, shots, partners, or frictional resistance such as water, air or ground resistance) offer the resistance necessary to develop the internal strength.

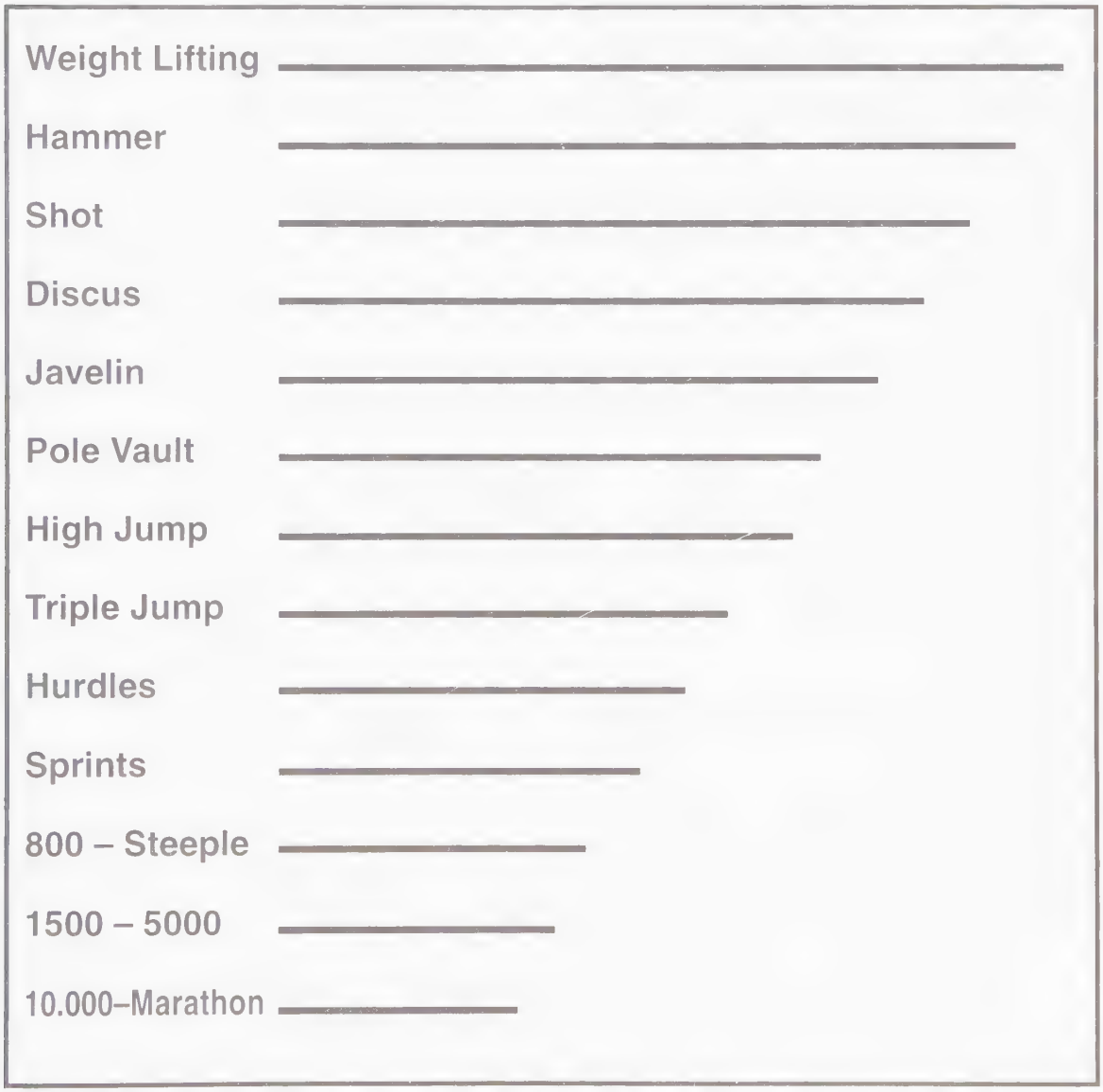


FIGURE 10.1 The role of maximum strength in various track & field events.

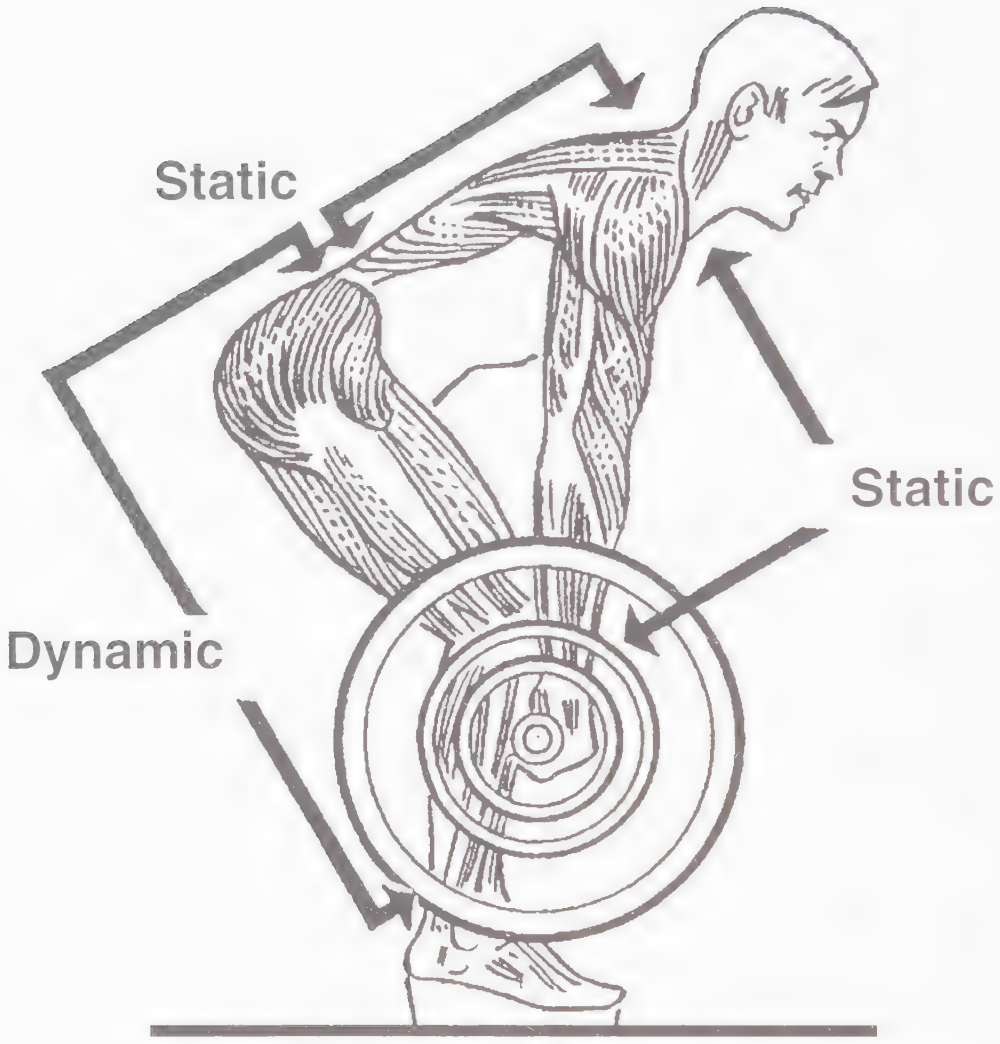


FIGURE 10.2 Static and Dynamic activities of muscles in a pulling motion (HARRE, 1981).

Figure 10.2 further demonstrates three phases as follows:

1. The Overcoming Phase (during the pull-up)
2. The Yielding Phase (during the lowering)
3. The Holding Phase (during the holding)

The Overcoming Phase is the most frequent in athletic movement. The muscles contract by producing chemical energy, thereby allowing athletes to move the weight they are working with or allowing them to move. The Yielding Phase supports the cushioning of jumps and performance of initial movements. The Holding or static Phase is an isometric contraction where there is no shortening or lengthening of the muscle fiber.

Having discussed the different types of strength, it is time to work on a program of strength development. In doing so, I would like to refer you to Table 10.1 where you can gain familiarization with the different categories. The different weight lifting exercises recommended for middle and distance runners are the Dead Lift, Squat (3/4 to full), the Bench Press and the Clean & Jerk. These four lifting exercises develop the gross (larger) muscles of the body which also include the major flexors and extensors. A description of these lifts is included later in this chapter.

The amount of strength necessary for both explosive and middle distance events, as well as distance running, is described in Table 10.3. It is important to develop proper techniques first, then to develop the strength goal necessary for one's age category. The principle of progression must be followed religiously in order to eliminate injury. Keep in mind that strength training is over and above the major workout which involves running. Once a goal is realized, you must then develop strength endurance, which is outlined in categories 5 and 6 in Table 10.1.

The amount and frequency of strength training should be considered in relation to the time of the training year in mind. These principles should be followed:

1. During the period of base training, athletes should lift three times per week on alternate days.
2. The strength training and running session should be separated by at least four to six hours in order to allow recovery from the first workout.
3. During the heavy competitive season, the strength workouts should be reduced to two times per week.
4. Strength development should be worked on during base and precompetitive periods. During the heavy competitive period, maintenance of strength should be the focus.
5. Strength training should be an ongoing activity throughout the year. Never start lifting just at the time you begin running.
6. Continue to lift until seven to ten days prior to the key competition of the year. At that time you can concentrate on major meet preparation without any strength loss.

Basic Lifts and Optimal Strength Goals

1 -	*Junior High*	*7th-9th grade*	*13-15 years old*
2 -	*Senior High*	*10th-12th grade*	*16-18 years old*
3 -	*Collegiate*		*19-22 years old*
4 -	*Post-collegiate*		*23 years*

Squat		**Optimal Strength for Explosive Events**	**Optimal Strength for Middle & Distance Events**
Jr. High	-	1.00 x Body Weight	
Sr. High	-	1.25 x Body Weight	
Collegiate	-	1.50 x Body Weight	
Post-Collegiate	-	1.75 x Body Weight	1.00 x Body Weight

Dead Lift		**Optimal Strength for Explosive Events**	**Optimal Strength for Middle & Distance Events**
Jr. High	-	1.00 x Body Weight	
Sr. High	-	1.50 x Body Weight	
Collegiate	-	2.00 x Body Weight	
Post-Collegiate	-	2.24 x Body Weight	1.50 to 2.00 x Body Weight

Bench Press		**Optimal Strength for Explosive Events**	**Optimal Strength for Middle & Distance Events**
Jr. High	-	1.00 x Body Weight	
Sr. High	-	1.14 x Body Weight	
Collegiate	-	1.44 x Body Weight	
Post-Collegiate	-	1.70 x Body Weight	.75 to 1.00 x Body Weight

Clean and Jerk		**Optimal Strength or Explosive Events**	**Optimal Strength for Middle & Distance Events**
Jr. High	-	.60 x Body Weight	
Sr. High	-	1.00 x Body Weight	
Collegiate	-	1.25 x Body Weight	
Post-Collegiate	-	1.25 x Body Weight	.60 to .75 x Body Weight

TABLE 10.3 The four basic lifts and optimal strength goals.

The Bench Press

This exercise is for the development of the chest and shoulders and for extensors of the forearm. Refer to Table 10.1 for a three or four set program.

FIGURE 10.3 A
Taking the barbell off of the rack.
Keep the arms fully extended.

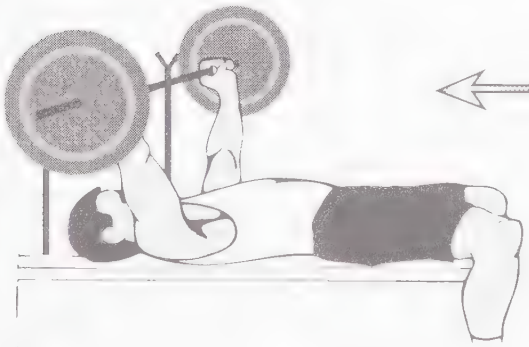


FIGURE 10.3 B
Starting position –
Palms upward, feet flat on the floor
and weight shoulder width apart.

FIGURE 10.3 C
Lower bar –
Make sure bar does not rest
on the chest.
Arms are fully flexed.

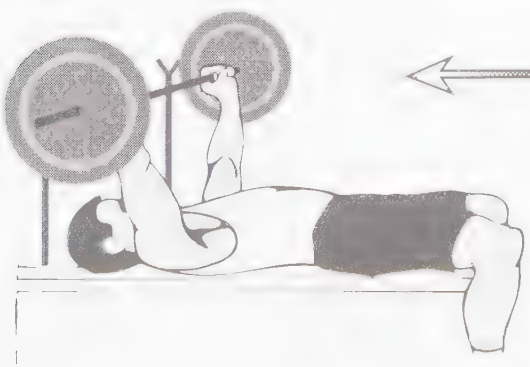
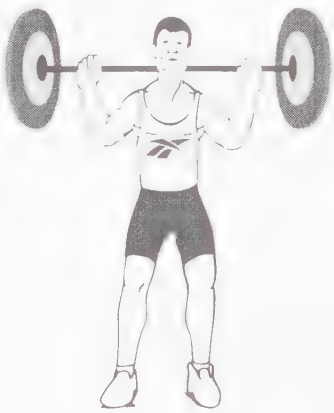


FIGURE 10.3 D
Press bar directly upward
until arms are fully extended.

The Full Squat

Muscle groups: Flexors and extensors of the hip, knee and leg.
Refer to Table 10.1 for a three or four set program.

FIGURE 10.4 A
Starting position–A
Stand erect, feet shoulder width.
Place bar on shoulders behind neck.
Use pronated grip and spread hands far apart on bar.



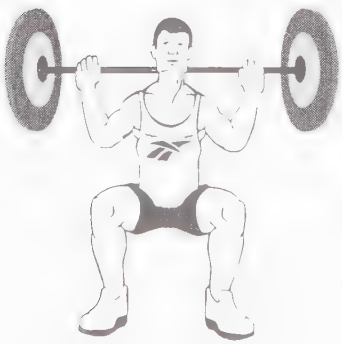
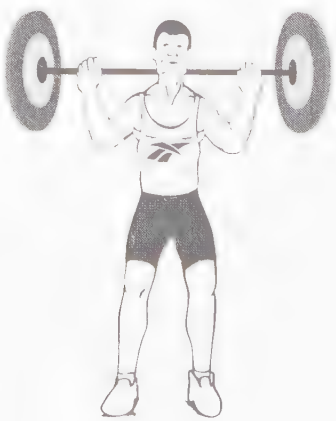


FIGURE 10.4 B
Movement–B
Keep back straight and head up.
Lower bar by flexing knees 90 degrees.

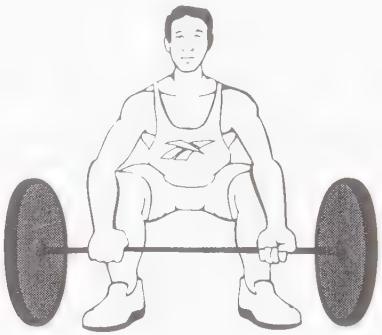
FIGURE 10.4 C
Movement–C
Return to starting position.
Repeat according to lifting schedule.



The Dead Lift

Muscle groups: Flexors and extensors of the hip, knee and leg.
Refer to Table 10.1 for a three or four set program.

FIGURE 10.5 A
Position–A
Feet shoulder width apart,
hands reversed on bar,
legs at 90 degrees, arms straight
and eyes looking horizontal.
Bar on platform.



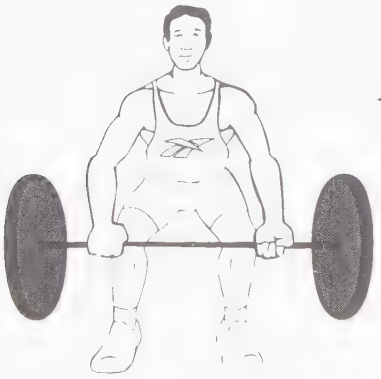


FIGURE 10.5 B
Movement–B
Begin standing up, look up and
keep arms extended at all times.

FIGURE 10.5 C
Movement–C
Complete standing up, arms
extended and shrug shoulders.
Continue to look up.

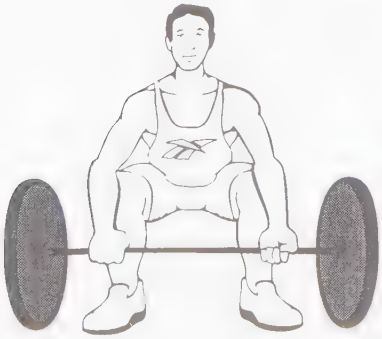


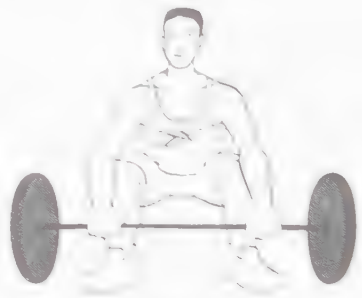
FIGURE 10.5 D

Lower body by flexing knees and
obtain same position as in A.
Repeat as prescribed in lifting
schedule.

The Olympic Clean & Jerk

Muscle groups: (A, B & C) Extensors of lower body, legs, hips, ankles, flexors of lower and upper arms and wrist. (D) Hip, leg lowering then extension of arm muscles. Refer to Table 10.1 for a three or four set program.

FIGURE 10.6 A Starting Position–A Feet shoulder width apart, eyes and head up, hands on bar slightly wider than your shoulders.



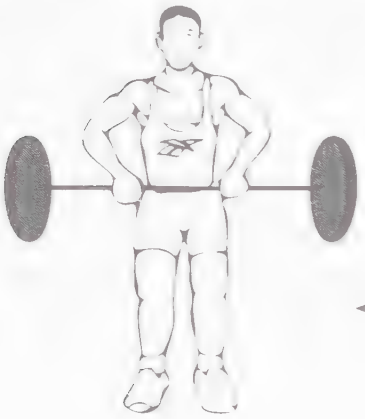


FIGURE 10.6 B Movement–B Stand erect at the same time that you lift the bar by flexing elbows. The bar position at the end of this maneuver should rest on anterior portion of shoulders (see Figure 10.6.C). It requires quick wrist action to get bar in resting position.

FIGURE 10.6 C

FIGURE 10.6 D Clean (or Press) Lower center of gravity at same time bar is being moved to an overhead position. Stand erect arms extended.

Plyometric Training

Plyometric exercises offer a potential bridge between strength and skill repetition which incorporates the reactive and elastic properties of muscle. These properties are amplified through exercises in order to heighten excitability of the nervous system, thus, improving the reactive capability of the neuromuscular system. This allows the athlete to develop a greater force production over a shorter period of time. Strength in itself is useless unless one develops strength at speed in relation to the particularities of one's event.

Plyometrics closely simulate the natural responses of daily and athletic movements. The normal muscle function in plyometrics is from a stretched eccentric position, followed by a concentric muscle contraction. In other words, it is a series of eccentric-concentric couplings. The quick, powerful movements involve a prestretch, or counter movement, that would activate the stretch and shortening cycle is what is meant by eccentric-concentric couplings.

Although at first it is necessary to develop strength through resistance training, it becomes difficult to blend strength with the functional demands of sport. Thus, in weight lifting, are we gaining anything except familiarity with the skill of weight training? The question to be asked should be: Does this actually result in an increase in functional abilities due to the variance in sport?

Physiological Principles of Plyometrics

A. The elastic properties of muscle fibers are as follows:

1. The Parallel Elastic Component (PEC) consists of the connective tissue, blood vessels, nerves and circulatory structure. It runs parallel to the muscle fibers.

2. The Series Elastic Component (SEC) is found in tendons. These nerves lie in a series in the tendons. Both PEC and SEC store energy when stretched.

"Get your body ready for that golden moment when opportunity arrives."

- Coach Joe Vigil

B. The reactive properties of muscles are controlled by two primary proprioceptors. Their characteristics are as follow:

1. Muscle Spindle
   - A stretch receptor.
   - Primary function is to monitor the overall length (stretch) and velocity of the stretch.
   - Response is one of activating muscle tissue to contract.
   - The greater the velocity of stretch, the greater the following muscle contraction.

   The goal is to improve the function of the Muscle Spindle.

2. Golgi Tendon Organ (GTO)
   - A stretch tension receptor.
   - Detects tension within the musculotendonous unit.
   - Has high threshold receptors.
   - Its response is one of muscle inhibition or causing the muscle to relax.
   - If tension is too great, no muscle contraction will occur.

   The goal is to get the maximum velocity of stretch possible without firing the GTO.

NOTE: Muscle Spindles (PEC's) are located in the muscle fibers and run parallel. Series Elastic Components (SEC's) are located in the tendons and run in series.

What can be gained with plyometric exercises?

A. Increased force production through increased stretch reflex.

B. Desensitization of the GTO, yielding a greater stretch reflex.

C. Neuromuscular Coordination:

- *Synaptic Modulation* – Each time a specific type of sensory signal passes through a sequence in the synapse, the synapse becomes more capable of transmitting the same signal the next time.

- *Synaptic Functions* – These can be modulated to increase or decrease the number of receptor sites for excitation or inhibition.
- *Demonstrated by Short-Term Memory* – It can provide rapid repetitive series of impulses which stimulate an excitatory response for a period of time. Next provide a short rest, resume the original stimulus, and consequently, the cell becomes more and more responsible.
- *Leads to the Development of Motor Engrams* – This is a memorized skill which is created by a permanent trace or configuration of certain cells and motor enzymes within the sensory portion of the brain.

The object is to select and teach tasks within the relevant conditions of the motor pattern to be learned. This is in order to attain the maximum benefits.

Principles to Follow When Creating Plyometric Exercises:

First, one must understand the phases of the plyometric exercises. Secondly, these phases are duplicated with increased intensity. Finally, an athlete should adhere to very specific guidelines.

A. *The Prestretch Phase:*

The muscle is stretched, activating both the Muscle Spindle and the Golgi Tendon Organs. During this phase, energy is stored in the PEC's and SEC's.

RULE: The prestretch must be short range and performed as quickly as possible without delay.

B. *The Amortization Phase*: (30 to 50 milliseconds)

This phase is significant and is a time of decision as to whether the Muscle Spindle or the Golgi Tendon wins out.

- If the prestretch takes too long, the Golgi Tendon Organs win.
- If the prestretch is appropriate, the Muscle Spindle wins.
- The shorter the Amortization Phase, the greater the Muscle Spindle response.

RULE: The most common error is to dampen (delay) the eccentric stretch. The athlete must react as if hot coals are on the floor, or as if he/she were landing on the surface of a hot stove.

C. *The Concentric Reaction Phase*:

The force production is produced by the contraction of the muscle and by the stored energy in the PEC's and SEC's.

RULE: React (in the contraction) with all the force at your command. When developing a plyometric program, these additional considerations are important:

1. The use of vigorous and intense exercises will desensitize the Golgi Tendon Organs.
2. The hypertrophy of muscle tissue creates more motor units and neuromuscular structures.

When is an athlete ready to begin a plyometric training program?

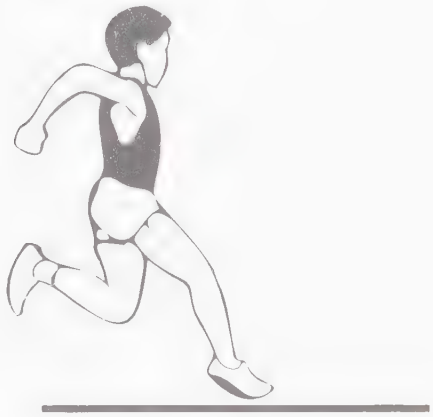
A. When the athlete meets the strength demands listed in Table 10.3.
B. When the athlete meets the muscular flexibility goals listed in Table 10.4.
C. When the following postural demands can be met. The following exercises must be performed for 30 seconds, first with open eyes, then 30 seconds with closed eyes.
   a. 1 leg stand.
   b. Quarter squat - one leg.
   c. Half squat - one leg.
D. Always consider variable of intensity, volume and progression.

Guidelines to follow:

1. Training should be specific.
2. Exercises should be performed at 100% effort.
3. The greater the intensity, the greater the recovery.
4. Maintain proper technique at all costs and when technique is lost, quit.
5. Start easy and increase complexity.
6. Plyometric exercises are practiced three times per week during developmental or base phases of training and twice a week during the competitive season.
7. Practice volume during base period and intensity during the competitive season.
8. Always apply the principle of progression when increases in overload are being added to a program.
9. The skill of performing proper technique is of great importance, and the athlete should always be made aware of breakdown in technique.

Leg Bounds (Right leg, then Left leg, then Alternate Legs)

FIGURE 10.7 A
Right leg landing.
Arms back.



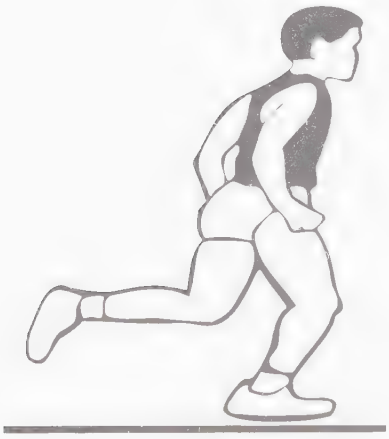
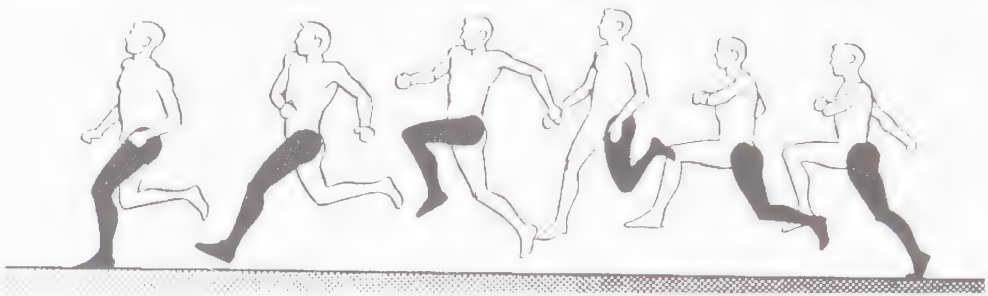


FIGURE 10.7 B
Gather for take off, driving left knee forward and upward until thigh is parallel to ground . Use arms to help you get center of gravity as high as possible to execute leg action.

FIGURE 10.7 C
While airborne, rotate left leg into butt kick before lengthening.

FIGURE 10.7 D
Brace for landing with right leg.
Work up to 10 right leg bounds,
10 left leg bounds and
10 alternate leg bounds.

Leg Bounding Exercises



Leg Bounds

1. After a 7 – 11 stride approach, execute 5-10 hops. Maintain balance and rhythm.
2. Maintain the upright angle of the body as in running.
3. The knee of the free leg should come up and forward at take off. The thigh is parallel to the ground.
4. Then swing back behind hopping leg.
5. The proper take off is from a flat foot on ground to a full extension on the ball of the foot.
6. At the take off, arms are either in a natural running action or in a double arm movement.

Program

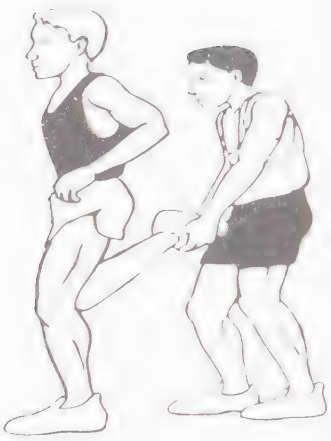
1. Execute a left leg bound taking off and landing on left foot.
2. Execute a right leg bound taking off and landing on right foot.
3. Alternate leg bounds: Right foot take off Right foot landing then – left foot take of left foot landing.

Work Load

1. Start off easy to acquire the correct skill and technical movements.
2. Start by bounding each leg 5 hops and alternate leg hops 5 times.
3. Then work up to 3–5 X 5 hops then 2–4 X 10 hops.
4. Increase workloads during Developmental Phase and maintain during Competitive Phase – 2 times per week for middle and distance runners.

Butt Kicks

FIGURE 10.9 A
Have a partner hold right leg standing upright.



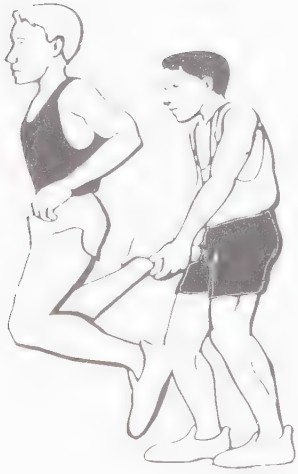
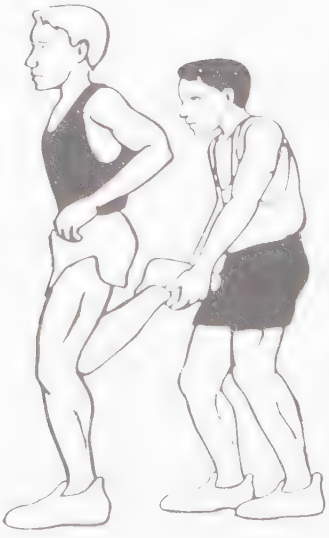


FIGURE 10.9 B
Butt kick using left leg with a quick and explosive action.

FIGURE 10.9 C
Land in upright position.
Speed of the kick is essential.
10 butt kicks with each leg/workout.



Depth (Box) Jumps

FIGURE 10.10 A
Develop eccentric contraction in leg muscles before concentric contraction jump onto box.

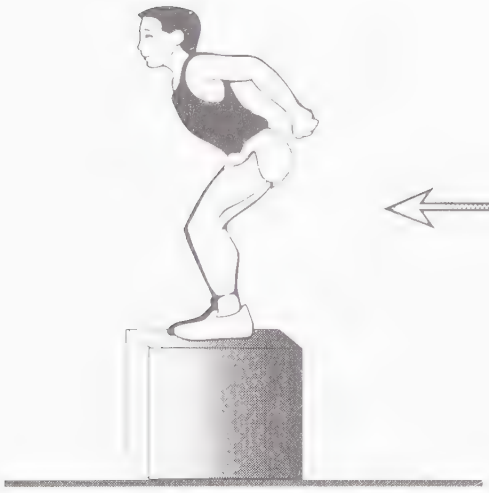
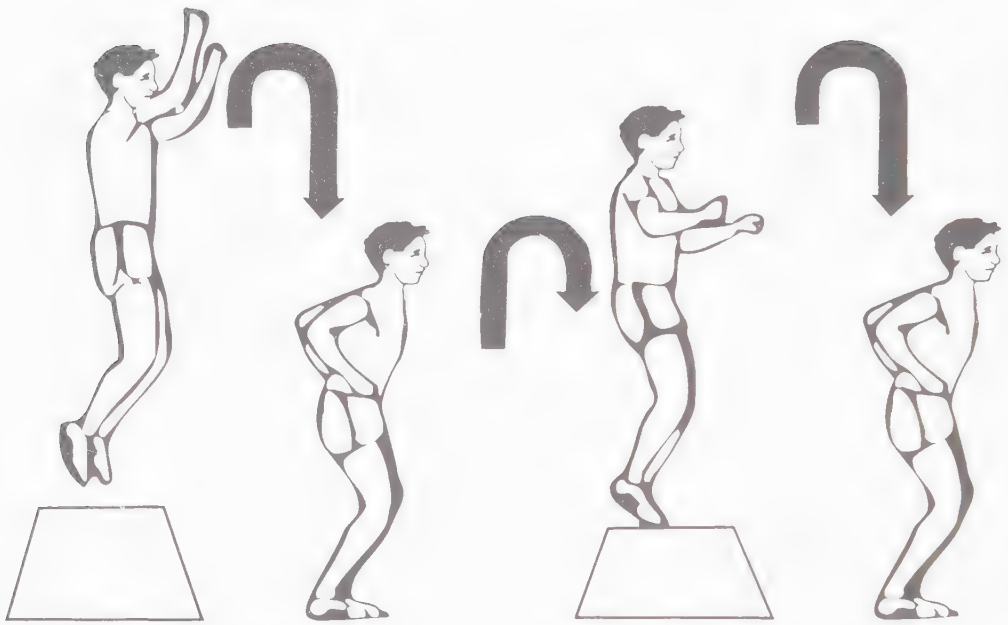


FIGURE 10.10 B
Land on box and let legs lower into eccentric contraction before concentric landing onto ground.

FIGURE 10.10 C
Land on ground after jump and again assume eccentric position before springing on to the next box. Work up to 10 jumps per workout.

Depth (Box) Jumps

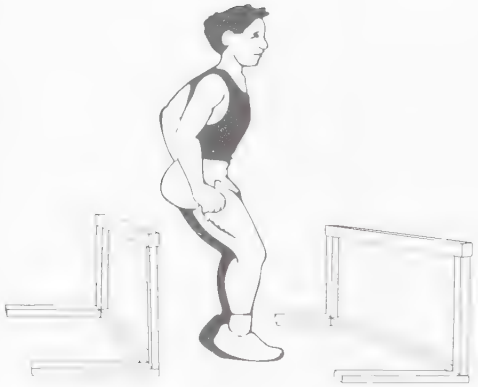


It has been shown that improvements in the reactive ability of the nerve muscle apparatus is best achieved by jumping from a height of approximately 65-70 cm (2'2"–2'3 1/2"). The maximum speed of neural innervation is developed when you switch from yielding work landing (slightly flexed leg position) to overcoming work (taking-off as fast as possible after landing) as illustrated above. More advanced athletes can practice right leg bounds and left leg bounds.

1. The height of depth jumps for middle and distance runners should be 65–70 cm.
2. On landing, take-off should be immediate for development of elastic recoil and stretch reflex contraction.
3. Depending on level of ability and strength, start off with a few and work up to no more than 30–40 jumps per session.
4. Depth jumps should be discontinued 10–14 days prior to key competitions.
5. Work up your volume during the Developmental Phase of training. Concentrate on technique and speed during the Competitive Phase.

Hurdle Jumps

FIGURE 10.11 A
Landing from a previous bound with feet together. Land between the hurdles with a 2 foot take off over the next hurdle.



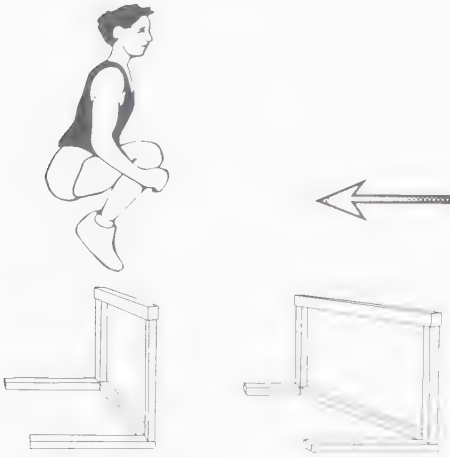
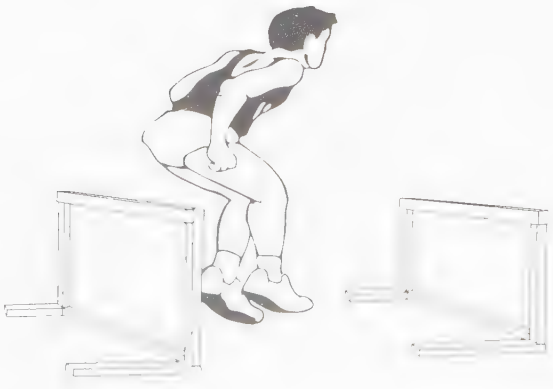


FIGURE 10.11 B
Flight over hurdle should have the arms parallel to the ground and a straight back. Use arms to help with the bound.

FIGURE 10.11 C
Extension of legs to meet the ground after bounding over the hurdle. Take off and landing should concentrate on eccentric then concentric contractions of the legs. Work up to 3–10 bounds per workout.



Double Footed Jumps Over Hurdle

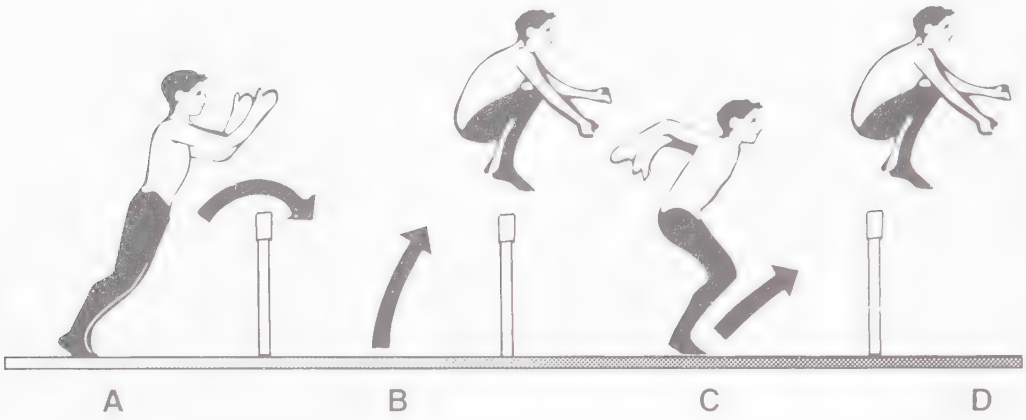


Illustration using 3 or 4 hurdles

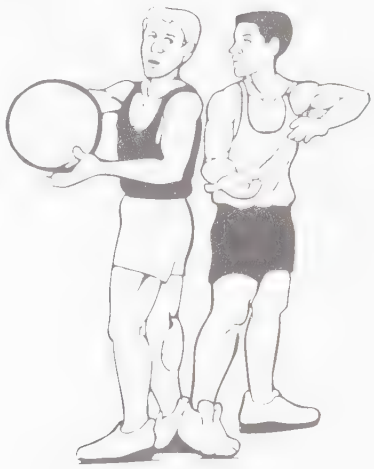
1. Drive the arms forward and up at the same time you extend the legs and hips for the take-off.
2. The arms should be moved to the side and then behind on landing.
3. It is very important to move arms to the side and then behind on landing. This prepares you for the next hurdle bound.
4. It is important when directly over the hurdle to keep trunk erect to eliminate forward trunk rotation and bring thighs to a position parallel to the ground. Flex the thighs on the hips.
5. Hurdle spacing should be adjusted to individual preference.
6. Start at 30", then progress to 33", 36", 39" and 42" heights to employ the over load principle.
7. Work up from 10–20–30–40 bounds twice a week.

"Results are achieved in direct relationship to the level of enthusiasm you bring to the track."

- Coach Joe Vigil

Medicine Ball Drills (Side to Side)

FIGURE 10.12 A
Stand back to back, feet firm.
Pass medicine ball to the left.



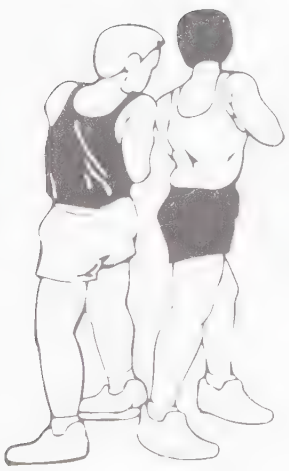


FIGURE 10.12 B
Receive by rotating to the right.

FIGURE 10.12 C
Again to the left. The emphasis is on the rotation of upper appendicular skeleton, hip and spine. Ten passes to each side per workout.

Medicine Ball Over Head Pass

FIGURE 10.13 A
Ball overhead.
Keep arms straight
at all times.

FIGURE 10.13 B
Catch and pass with
arms straight as possible.

FIGURE 10.13 C
Emphasis on arms and
in muscles stretching
eccentrically before
contracting to pass
the ball. Ten passes
per workout.

Medicine Ball Chest Passes

FIGURE 10.14 A
Standing 8–10 meters apart, pass medicine ball back and forth.

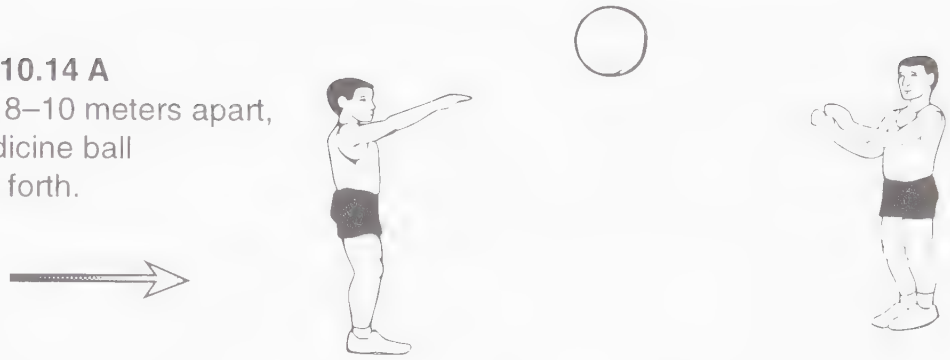


FIGURE 10.14 B
Concentrate on full extension of the arms.

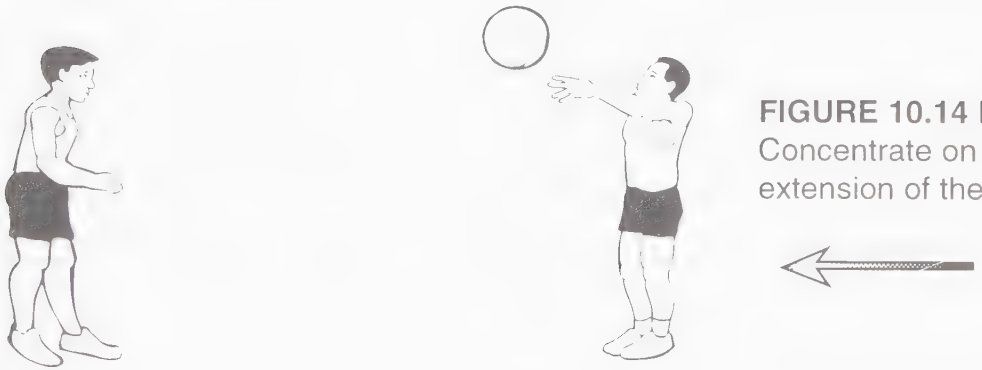
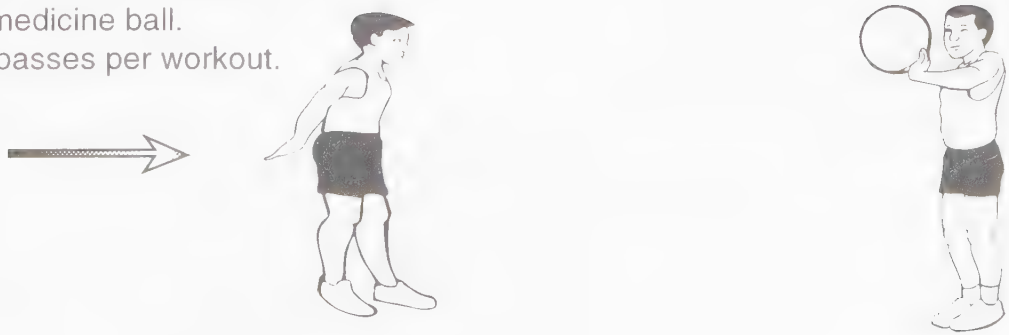


FIGURE 10.14 C
After allowing the arms to flex fully upon catching the medicine ball. Ten passes per workout.

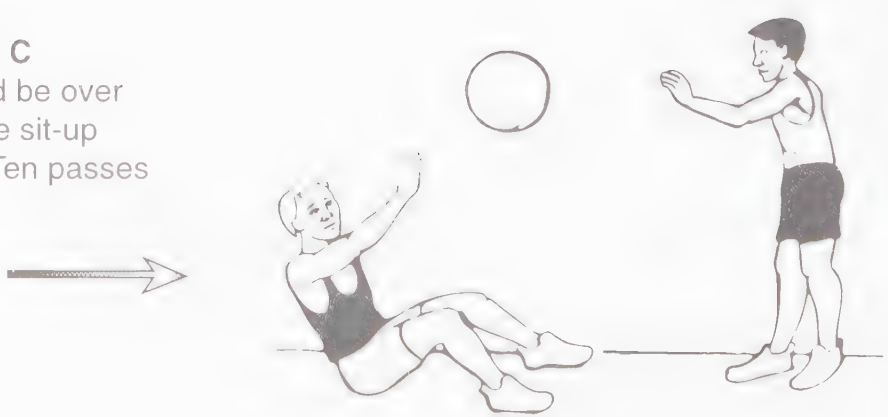


Medicine Ball Pass While Sitting Up

FIGURE 10.15 A
Catch the ball as you sit down in starting position of sit-ups.

FIGURE 10.15 B
Pass the ball as you are sitting up.

FIGURE 10.15 C
The ball should be over the head as the sit-up is completed. Ten passes per workout.



FLEXIBILITY

Flexibility may be defined as the functional capacity of the joints to move through a full range of movement (ROM). The determinants of this process are the length of the muscles, ligaments and tendons.

Research has revealed that inactive people are usually less flexible than persons who are more active. The major reason for this premise is that inactive persons spend much more time sitting, in which case certain muscle groups are constantly in a fixed position. A person who sits at his/her job the majority of the time exhibits flexion of the knee joint, hip joint and elbow joint. To maintain this position for prolonged periods of time, results in these muscles and connective tissue becoming much shorter than they should be. Stretching (flexibility) exercises are necessary if adequate flexibility is to be kept and if muscles are to retain their normal length. Without the proper amount of flexibility, no one can function at an optimal level.

The development of flexibility requires intense movement of the body parts through a complete range of motion several times each day. For those whose lifestyles do not result in such movement, it is advisable to participate daily in selected exercises that cause movement of the joints through a full ROM.

Exercises that are performed slowly appear to be more beneficial and less likely to result in injury. When the exercise achieves its full ROM, it is appropriate to hold it for six to eight seconds (a static stretch). This type of stretch is more beneficial than dynamic exercises where bobbing, bouncing or jerking movements are initiated. This stretch results in fewer injuries.

When a flexometer is not available to measure specific joint movement, a number of specific tests (developed for classroom or field use) are described as follows. (Figure 10.16 A, B, & C – Study the testing procedure to evaluate your runners.)

"You make the impossible happen by virtue of your drive."

– Coach Joe Vigil

Flexibility Testing

FIGURE 10.16 A

Sit and reach test

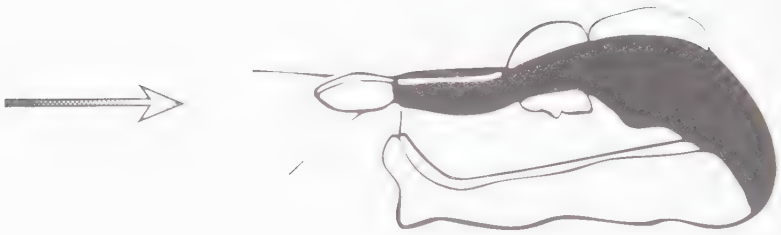


FIGURE 10.16 B

Trunk extension test

FIGURE 10.16 C

Shoulder lift test

Trunk Flexion - Sit and Reach

The degree of trunk flexion will depend upon the length of the trunk extensor muscles of the back and the hamstring muscles. The subject assumes a sitting position with the knees fully extended. The bottom of the feet are against the surface of a bench, or another object with a flat surface about 13 inches high. The hands and arms are stretched forward as far as possible. This position is held for three seconds. A ruler or yardstick is used to measure the distance in front of, or beyond, the vertical edge of the bench. Measures in front are negative; measures beyond are positive.

Trunk Extension

The trunk extension is a measure of the range of motion when the back is arched from the prone position. The subject lies face down on the floor with a partner holding the buttocks and legs down. The fingers are interlocked and the head and shoulders are raised as far as possible from the floor. The distance is measured from the floor to the subject's chin with a yard stick.

Shoulder Lift

The shoulder lift test measures the range of motion (flexion) at the shoulder joint. The subject lies face down on the floor with arms parallel, extended and hands holding a ruler. The chin and the forehead must remain on the floor while the ruler is raised as high as possible with the arms straight. The wrists must not be bent upward in an attempt to achieve greater height. This position is held for three seconds and the distance from the floor to the lower edge of the ruler is measured with a yard stick.

	Male			Female		
Percentile Rank	Sit & Reach (Inches)	Trunk Extension (Inches)	Shoulder Lift (Inches)	Sit & Reach (Inches)	Trunk Extension (Inches)	Shoulder Lift (Inches)
95	+ 7+9	24	28	+ 6+8	22	27
90	+ 6+9	23	26	+ 5+9	20	25
80	+ 5+8	21	24	+ 4+9	18	22
70	+ 5+0	20	23	+ 4+1	17	21
60	+ 4+3	19	21	+ 3+6	16	19
50	**+ 3+6**	**18**	**20**	**+ 3+0**	**15**	**18**
40	+ 2+9	17	19	+ 2+4	14	17
30	+ 2+5	16	17	+ 1 +9	13	15
20	+ 1+4	15	16	+ 0+9	12	14
10	+ 0+3	13	14	+ 0+1	1O	1
5	+ 0+7	12	12	+ 0+8	8	9
Mean	+ 3+6	18	20	+ 3+0	15	18
SD	+ 2+6	3+8	4+8	2+3	4+1	5+3

TABLE 10.4 Flexibility Profile Chart - Once it is determined what percentile rank an athlete is, he/she can then concentrate on various flexibility exercises in order to improve weak areas as well as to maintain areas which test as acceptable.

Flexibility & Strength Exercises – Sit-ups

FIGURE 10.17 A

- Make sure legs are flexed.
- Keep constant tension on the abdominal muscles.
- Motion must be smooth and not jerky.
- Strive for 50 sit-ups in 1 minute.

FIGURE 10.17 B

Make sure shoulder blades are 4" to 6" off the ground.
Position assumed in sit up position.

FIGURE 10.17 C

When going back down, let shoulder blades touch ground.

Head should not touch the ground.

Push-ups (Clapping)

FIGURE 10.18 A
Arms fully extended.
Clap hands together while going up.
Arms fully extended before going back down.
Strive for 25 continuous clapping push-ups.

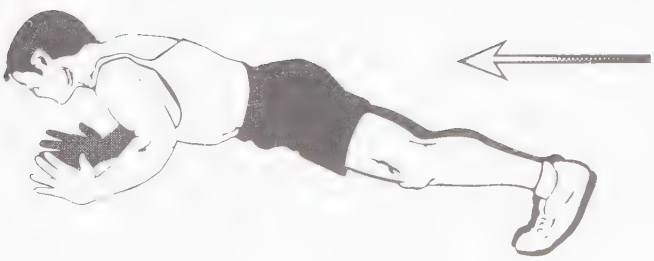


FIGURE 10.18 B
Keep back straight at all times.

FIGURE 10.18 C
Women perform push-ups
without clapping action.

FIGURE 10.19 Hamstring Stretch
Assume correct position.
Straighten leg until you feel burning sensation in the hamstring.
Hold 6–8 seconds.
Relax leg. Repeat.
Four–six static stretches with each leg per workout.

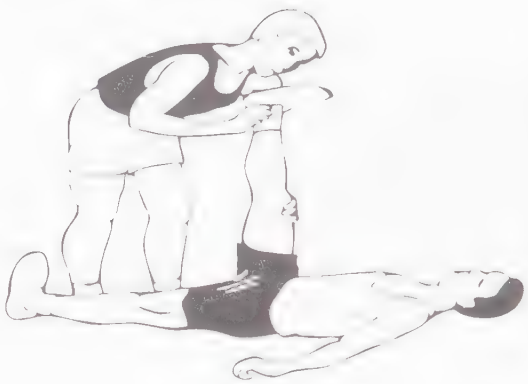


FIGURE 10.20 Adductor Stretch
Put pressure on knees with elbows.
Place thighs and calves as close to the floor as possible.
Lean forward from the hips until you feel full stress in the groin.
Repeat 4–6 times per workout.

FIGURE 10.21 Calf and Achilles Stretch
Continue to walk backward, thus, applying more and more stretch to the lower leg.
Make sure rear foot is flat on the ground.
You must move hands down the wall as you walk backward.
Three–four stretches with each leg per workout.

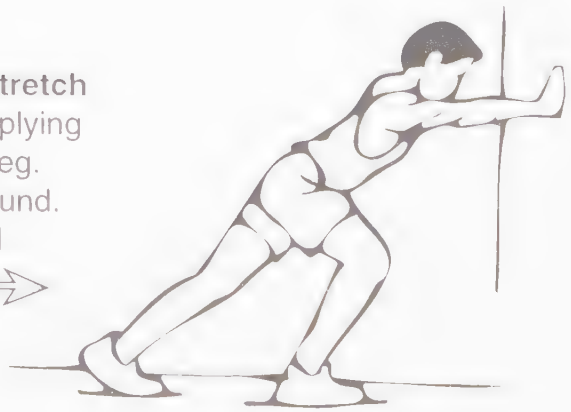
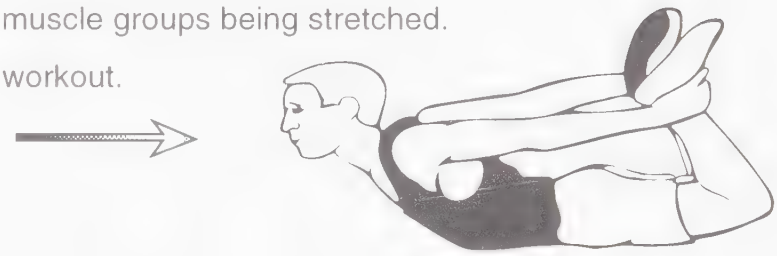


FIGURE 10.22 Hip Flexors and Abdominal Stretch
Arch the back as much as possible.

Apply tension on the anterior quadriceps group.

Pull down on ankles and lift trunk upward to apply a greater overload on muscle groups being stretched.

Stretch 4–6 times per workout.



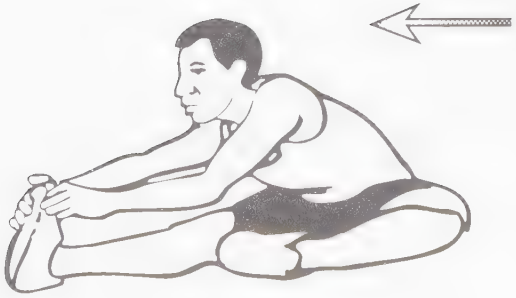


FIGURE 10.23 Hurdle Stretch
Alternate legs and keep the toes up.
Lean forward from the hips.
Feel the stretch in your hamstring and lower back.
Goal is to keep extended leg straight.
Go forward until face touches knee.
Release tension and repeat 4-6 times per leg per workout.

FIGURE 10.24 Gluteal and Sciatic Nerve Stretch
The stretch tension will be on crossed over leg.

To increase tension, bring grasped leg forward towards trunk.

Feel tension in gluteal and lower lumbar region.
Four-six stretches with each leg per workout.

It would be ideal for athletes to practice ancillary activities three times per week during the developmental or preparation (base) phases of their training. During the heavier competitive season it is advisable to practice selected activities only twice per week. The emphasis during this period is on maintenance.

With the heavy work days that athletes have, it is sometimes difficult to find a time slot that will include these types of activities. What we have done very successfully with both student athletes and post-collegiate athletes is detailed below:

Sunday	a.m.	Running Workout
Monday	a.m.	Flexibility
	p.m.	Running Workout
		Weights / Plyometrics
Tuesday	p.m.	Running Workout
Wednesday	a.m.	Flexibility
	p.m.	Running Workout
		Weights / Plyometrics
Thursday	p.m.	Running Workouts
Friday	a.m.	Flexibility
	p.m.	Running Workout
		Weights / Plyometrics
Saturday		Competition - or -
		Running Workout

14 Training Lessons per week

TABLE 10.5 The number of workouts per week athletes should be involved in. If the athlete has a morning run three or four times per week, it would increase to 18 training lessons per week.

Study Guide

1. Survey the athlete's strength potential for optimal performance. Is it sufficient or lacking?

2. Review the four basic lifts. Determine the lifts the athlete will rehearse, the amount of resistance to be overcome and the frequency of workouts.

3. Pay attention to the point in the season the athlete will attempt to maintain or increase strength.

4. Under what conditions is it safe for the athlete to attempt plyometrics?

5. The learning of proper technique always comes before increases in progression.

6. What is the athlete's flexibility profile?

7. What regions of the athlete's body exhibit weaknesses or strengths?

8. What flexibility exercises will the athlete practice?

9. What day in the week and at what time of the day will the athlete practice ancillary activities?

10. The principles of overload and progression apply to ancillary activities.

An example of positive team dynamics in full bloom. Happy team mates celebrate the victory and rejoice in the joy of one of their team becoming the Individual National Champion.

11 Team Dynamics

"If one advances confidently
in the direction of his dreams, and
endeavors to live the life which he has imagined,
he will meet with success unexpected in the common hours."

- Henry David Thoreau

Overview

Motivation is hard to define and difficult to describe, yet it is one of the strongest forces known to humankind. The team concept is an important factor in initiating the highest possible motivation. It allows for individual and group interaction, providing the synergistic effect for the goals of victory and success.

Introduction

This chapter on team dynamics deals with bringing together a team and motivating them individually and as a group. It does not present the customary psychological principle but, rather, is based on what team members have felt has been important. It is about the day-to-day activities and the group interaction that has motivated athletes to go on and achieve the highest degrees of excellence in their chosen sports.

This is a story on how to bring out the best in people and not give them the opportunity to wallow in mediocrity as so many groups and individuals around them do. The results of this team dynamics motivation is the backbone of what produced the Adams State College dynasty–one that ruled during the decade of the 80's and part of the 90's. A dynasty that produced *87 individual national champions, 17 national championship teams, and 400 "All Americans."*

"You have something to get up for every morning. You're loved. You have a team." *Coach Joe Vigil*

All these accomplishments were done within a 24 year span. This record was established by individuals who were only average runners in high school. Under the influence of positive team dynamics and proper motivation, they made their contributions toward the enhancement of their teams. It was this dynamic interaction between coach, athlete and school activities in which all team members functioned as one. This is where the orchestration of success was played out.

Motivation is hard to define, and difficult to describe, yet it is one of the strongest forces known to mankind. It is a force that energizes and allows people to act. They eventually give their lives to the goals and visions that they have established for themselves.

If cross country and track and field coaches would take charge of their jobs and coach their teams in both physical preparation and motivation, the levels of success they would experience would be beyond their fondest expectations. Physical preparation is what this book is about, but coaches and athletes must not forget that mental preparation and motivation are equally important. In the beginning of a new training year, the emphasis is always on the physical. As the weeks and months begin to pass, the emphasis shifts to mental preparation. Once the heavy competition begins, it is 90% mental.

"ATTITUDE is our magic."

"We are going to coach for EXCELLENCE. We can get you ready physically, you have to get yourself together mentally."

Coach Vigil at team meeting

Team and individual dynamics are very complicated and different for every team. It is up to the coach to determine what should be done to bring the team together. In developing a team concept, I have found the following areas to be extremely important, and I will discuss each one separately.

I. Develop a Team Covenant
II. Understand and accept the power of motivation
III. Understand how to develop mental toughness
IV. Understand the principle of commitment
V. Understand how to bring out the best in people

I. The Team Covenant

In my coaching, once I had identified who was trying out for the team, a Team Covenant (philosophy) was given to them. This covenant was also given to parents so that they would fully understand the agreement and philosophy under which the team would operate. Covenants are manuscripts or agreements that bind groups of people, organizations, and religious groups together. Positive covenants bring people together in a constructive manner. When group members discover that something is good for the group, it becomes the guiding force that energizes the group into action. The team becomes more important than the individual.

"Whatever problems might exist, I have to help my team win a national championship."

—Phillip Castillo, 1992 National Champion, cross country

Over the years our team members learned that they had to make many sacrifices for the good of the team. In doing so, it helped the individual to forget about the "I" or "Me" concept and consider the welfare of the group. When this type of interaction is occurring, the coach and team members quickly realize that they have a team rather than a group of individuals acting independently.

The covenant at Adams State College was a document describing the philosophy necessary for success. Anyone who ever thought about being on the team had to read, understand, and agree to this philosophy. Every day a team meeting was held. Points of the covenant were discussed over and over until it became ingrained in their behavior. Team covenant includes the following:

A. ***Develop a good sense of values.***

A love for your sport.
An unquenchable thirst for knowledge about your sport.
A course of action to bring this about.

B. ***Choose a goal and work toward it.***

Goals had to be realistic. They could also be altered if set too high or too low. All activities were geared toward reaching these goals. If the activities of the athletes were negative or counter productive, they were reminded of it and set back on course. As they worked toward their goals, they developed a purpose and began to believe in themselves. It was this belief that helped them develop a relentless quest for excellence.

C. ***Athletics is a function of education.***

Remember that the main purpose for attending school is to do the best job possible academically. The habits developed in pursuing this objective will certainly carry over into athletics. If you are a good student, you generally are a good athlete and, conversely, a poor student will be a poor athlete. A coach must know what his athletes are doing in the classroom at all times. Constant individual or team reminders are certainly in order.

In the 80's and 90's most athletic departments in America became alarmed over the low grades, rate of attrition and poor graduation rate of athletes. At Adams State College the 30 year record for recruited athletes was a graduation rate of 94.5% and a 3.0 – 3.2 GPA. In any institution, it is the coach's job to push academics. If coaches do not, they simply are not doing their jobs. Athletes must be taught that academic success is their responsibility, not the responsibility of the counselors or academic advisors. Our team members were as proud of their academic success as they were of their athletic accomplishments. They also strived to improve academically from semester to semester, year to year, much the same as they tried to improve athletically season to season.

D. ***Qualities of the mind.***

It has been stated that anyone can exert an effort for a few minutes or a few hours or a few days. True success comes when that effort is extended over years of training.

The athlete must develop an enthusiasm on which such persistence is built. This persistence develops the impassioned will. This persistence develops the spirit to succeed.

It is easy to worry about your mistakes, but you must not worry. You must remind yourself that adaptations take time to develop. You must develop the courage to hang in there five minutes longer.

E. ***The place of athletics in your life.***

I always taught athletes to keep athletics in its place. My athletes were taught to be passionately involved in the sport and to exert themselves to succeed. They were taught to gain satisfaction from training and

competing. As you prepare for a season, it is easy to become self-centered about training to the exclusion of everything else. So, all your daily activities must be placed in the proper perspective. You must study, work, eat, take care of domestic responsibilities and be concerned about others. You must learn to keep athletics in its proper place, behind religion, family, the general welfare of the world (team, friends, and society) and education.

"Believe in yourself. Be upbeat. Positive. Live the athlete's lifestyle 24 hours a day.
Plan your day — live your life — like a winner."

Coach Vigil at team meeting

II. The Power of the Motivator

A widely accepted belief about motivation is that no one motivates anyone – that all motivation comes from within. Think about this for a moment. When have you been at your best? Was it not due to the influence of some inspiring person? Maybe it was a coach who could get more from you than anyone else, a teacher who knew how to make you study a little harder, or a boss who would make work a little more fun and had a way of pulling people together.

I think of Churchill, Napoleon, or MacArthur whose very presence made all the difference in the world. The way Churchill was able to pull his country together when it seemed hopeless and headed for defeat. The way Napoleon motivated his soldiers against insurmountable odds when he led them. The way MacArthur was able to turn defeat into victory because of the great courage his soldiers saw in him.

Athletes respond to the power of the motivator. Whether it be a coach or a leader on the team, it is a person who will galvanize the will of the individual or group into acts that have never before been achieved.

At times we come into contact with people who are waiting for their vacuum to be filled by some person who can impart vision and steer their energies into the direction of their goals. As a coach, I never looked at the athlete as being lazy. They were only athletes whose energies had never been tapped in the right way and had never been motivated to act.

As I look back, I remember a young man coming into our program from Sterling Colorado, from a school who's history in running was anything but successful. Rick Robirds found the motivation that he had longed for. As a result, he was motivated

to go on and become one of only four athletes in the history of cross country to win 3 individual national championships during his college career. A remarkable accomplishment indeed.

It is the coach's responsibility to seek those athletes he can relate to and to establish the working environment necessary for the athlete to succeed. As McGinnis once said, "The manipulator tries to persuade people to do something that is not in the their best interest but in the best interest of the manipulator. A motivator finds goals that are good for both sides, then welds together a high achieving, high morale partnership to achieve them."

"You already have more than most people in the world. What you need is more heart, will, courage, and focus."

Coach Vigil at team meeting

Athletes are taught and constantly reminded of the three prerequisites for success:

- ✔ *Develop an unshatterable belief in yourself.* Most athletes don't believe they have the ability to achieve the goals they set for themselves.
- ✔ *Develop an unshatterable belief in your coach or team leaders.* The lack of confidence that athletes have when they don't think their leaders are capable leads to inhibition. This ultimately results in failure to achieve goals.
- ✔ *Develop an unshatterable belief in your philosophy of life.* Learn to understand and appreciate your roots, what direction you are headed and where you want to be in the future.

All athletes must be reminded that they are there by choice. They want to be runners. In many cases athletes act as if they are doing the coach a favor by being there. The individuals who exhibit that type of behavior work as a liability on the team and strain the athlete/coach relationship.

When an athlete decides to become a part of a program, he/she is going to expend a lot of time and energy. These are valuable gifts, perhaps the most important an athlete has to offer at that point in their lives. The coach has a huge responsibility not to waste these gifts on improperly developed workouts that lead nowhere. If the athlete can understand the synchronization of the training, the

education and the fellowship he/she is involved in --- if athletes can see how it will ultimately help them get to their goal --- they have found the biggest motivation of all. It is not difficult to get people to work individually, or as a part of the team, when the motivation is there.

At my daily team meetings, athletes were reminded of the many objectives to be accomplished. I vividly remember how focused the athletes were as I spoke of the many things which involved them. The graphic examples discussed in these meetings merely showed them that it was hard to separate excellence from right living. They learned to live right and produced excellence as a result. I had to be a creator of the athlete's personality, not a destroyer. As the athletes participated in the daily team meetings, they all began to believe in themselves and in the team concept. We developed a relentless pursuit of the ideal we were after. This did more to motivate the athletes than anything else. These types of activities are important in all sports and in all human activities. In this manner, the coach who leads these activities, becomes the motivator.

III. Developing Mental Toughness

One of the most evident characteristics of human beings is our inconsistency in all of life's endeavors. Why are you motivated one day and lack motivation the next day? Why can you perform well in athletics at times, yet, at other times, you seem down? It seems as though you are on a performance roller coaster - one day up, one day down, an inconsistency that leaves you frustrated and strangely out of control. You rarely play or perform to your full potential when it counts.

This condition can be a powerful reason to trigger guilt, self-doubt, anger, and self-criticism. Most athletes have experienced this condition at one time or another during their careers. Sometimes this condition is reason enough for athletes to drop out of their chosen sport. The frustrations and mental anguish are just not worth it, so they go on to other things. The big question and ultimate goal for all athletes, regardless of age or level, is how does one achieve consistency in athletic performance and life?

The one aspect of our program at Adams State College that athletes believed helped them the most was a regular review and reminder by the coach on the development of mental toughness. The focus of every athlete should be to perform and train with consistency and work to their full potential. Consistency is the ultimate measure of mental toughness in all athletes. It is also the characteristic of real champions. When athletes perform at the upper range of their talents and skills, day in and day out over a season, their real potential flows into the development of

greatness. Proper technique is necessary because poor biomechanics will lead to inconsistency. Proper mental skills are also required for consistency. The mentally tough competitor who is consistent has developed an environment to perform consistently.

One thing we must all be aware of is **mental toughness is learned. You are not born with it**. Personality is unrelated to mental toughness. Either introvert or extrovert, quiet or boastful, dynamic or reserved, these characteristics have nothing to do with your success as a competitor.

"Running must be a passion, not an obsession."

Coach Vigil at team meeting

You do not have to move out of your comfortable personality style to achieve a high degree of mental toughness. There are a number of mental skills, all of which are learned, which are characteristic of mental toughness. Dr. James Loehr in his work on athletic excellence, developed a training model, AET (Athletic Excellence Training), that I have used successfully over the years.

The nine steps of Dr. Loehr's model are:

1. **Be self motivated and self-directed.**

   A person should not have to be pushed, shoved or forced from the outside. Direction comes from within. A person is involved with the sport because he/she wants to be. (However, using the support and inspiration of the coach greatly enhances all achievements.)

2. **Be positive but realistic.**

   The athlete is not a complainer, a criticizer or a fault finder. He she is a builder, not a destroyer. The athlete's trademark is a blend of realism and optimism, with an eye always fixed on success, on what can happen, and on what is possible. There were many times when I detected the opposite characteristics in some of our athletes. I would see fit not to let them work out with a positive team because I believe that negativity is infectious and actually affects the whole group. The team morale was a part of my responsibility as a coach.

3. **Be in control of his/her emotions.**

   Any real athlete understands the unfortunate performance consequences of poor emotional control. Bad officials, late time

schedules, stupid mistakes, obnoxious opponents, and poor facilities, all represent powerful triggers of negative emotions. Anger, frustration, and fear must be controlled or they most certainly will control you. The tough competitor has to tame the lion within.

4. **Be calm and relaxed under fire.**

Athletes don't avoid pressure. They are challenged by it and at their best when the pressure is on and the odds are against them. Being put to the test is not a threat. It's but another opportunity to explore the outer limits of potential. Too often athletes will spend countless hours or days worrying about the upcoming competition, leaving them emotionally drained and spent. The consequences often are disastrous.

5. **Be highly energetic and ready for action.**

Athletes should be capable of getting themselves pumped up and energized for performing their very best, no matter how they feel or how bad or meaningless the situation. The athlete is his/her own igniter and can do so in spite of fatigue, personal problems, or bad luck.

6. **Be determined.**

Having once started, the athletes sheer force of will to succeed is beyond comprehension of those who do not share the same vision. They are relentless in their pursuit of goals. Setbacks are taken in stride as he/she inches forward.

7. **Be mentally alert and focused.**

Athletes are capable of long and intensive periods of total concentration. They are capable of tuning in that which is important and tuning out that which is not, regardless of the pressure. The athlete has attention control. Far too often athletes fall asleep in one of the stages of their race because they are poorly focused. Sometimes friends and family interfere with this focus. In the past, whenever possible, I would have meetings with family members and tell them not to interfere until after the competition.

8. **Be doggedly self confident.**

The athlete must display a nearly unshatterable sense of self confidence in the ability to perform well. Those who are confident rarely fall victim to their own or others' self defeating thoughts and ideas. As a consequence, the athlete is not easily intimidated. On the contrary, because of a confident appearance, he/she often becomes

the intimidator. On many occasions in the past, the tremendous team confidence and spirit displayed prior to competition would intimidate other teams so badly that they were beaten prior to competition. Team confidence was always the Adams State College tradition.

9. **Be fully responsible.**

   The athlete must take full responsibility for his/her own actions. There are no excuses. They either do or they don't. Everything begins and ends with the individual, and they have to be perfectly comfortable with that. They must be fully aware that their destiny in life, as an athlete, is in their own hands. Their future is their own and they can blame no one, regardless of the consequence. Too often individuals are prone to blaming others for their weak outcomes. Those who fail are not mature enough to handle the responsibility of the activity they, seemingly, want to be involved in.

Finally, the understanding and dynamics of these tenants seem to be a major motivational thrust for those who review and practice them. If there are weakness or reasons for failure, it is because athletes fail to understand or do not practice either one or all of these tenants. The road to mental toughness and consistency in athletics, and to life in general, can be found through an understanding of these steps.

IV. Team Commitment

Pat Riley, in his book "The Winner Within," states that a must for all coaches is to blend the talents and strengths of individuals into a force that becomes greater than the sum of its parts. This synergism is the objective that coaches must make happen. Teamwork is the only way for a team to reach their lofty goals, to produce the ultimate moment, to make breakthroughs and define individual purpose as a team member, and finally, to fill their lives with a real sense of purpose.

This is a force that shapes both an individual and a team. It helps develop an environment in which excellence becomes the rule rather than the exception. The amazing thing about developing a team concept is that it applies not only to athletics, it applies to families, education, business, industry, a neighborhood group, or a congregation. Everyone of these groups develops a team stage setting to act out the drama of their lives. When the group excels, they win. In an athletic team setting we are part of something that matters. Our efforts, combined with those of the team members, develop into something that matters. The group effort is more

satisfying than anything we could have achieved on our own. It is the fountain from which all our rewards ultimately flow.

Team work is not simple. It can be a very frustrating and elusive goal. I've seen many athletic groups who pretend to be teams but their actions point to individualism. A team is not a chance happening. It is a group of people in which the rhythms of teamwork are blended into the rhythms of life. The dynamics of these two rhythms produce a flow of ambition, power, cooperation and emotion that triggers the possibilities of making one's dream come true.

It is only natural for people to want to be a part of something. They want to identify with leaders or greatness. When they do become part of the group or club, it then becomes their territory. Biological instinct has taught us to protect our ground. Teammates are taught to understand their space, to trust in each other, to uphold the tradition and principles, and to protect the integrity of their team. These actions are developed and talked about in team meetings. The coach, team leaders, and senior team members perpetuate this attitude at team meetings or gatherings of any kind. It is the forward motion that increases from year to year.

Over a twenty year period, the team meetings at Adams State perpetuated a great force where all the right things occurred. The athletes were able to energize each other, often in times when they felt as though they could not workout for one reason or another. Everything was put aside for the good of the team. Absenteeism was never a problem; it simply did not occur. The team experienced a belief that something great was going to happen. When this attitude was nurtured and developed, the team could sense and feel their climb toward greatness and excellence.

In my coaching at Adams State College, at the beginning of a season, I would put a big sign up behind me. It was positioned so that all team members could see it. It stated "If you do not believe we can have a national championship, you don't belong here". The seniors, the juniors, the sophomores and, finally, the freshmen would stand and read it. We knew from the reaction and attitude developed at team meetings that, with whatever talent we had, the team had dedicated itself to unselfish commitment to excellence, and it was ready to climb to another conference, regional, and national championship. So strong were the positive attitudes developed at the daily meetings, that our athletes became dependent on these for a daily nurturing of the goal as surely as one becomes accustomed to eating food.

I will never forget the concern that our team members had for each other. The team had learned that one of the members was nearly blind and was in need of

contact lenses. Over a period of time the team saved money and eventually had enough to buy the team member a pair of contacts. He went on to graduate and become "All American" that year. In all my years of coaching, I had never experienced the thrill of watching the team embrace the success of "one of their own" making "All American" over their own success. I felt that the pride, the physical and mental preparation, and the team focus we had always talked about was unfolding before my eyes. This meant more to me as a coach than all the championships we ever won.

V. Bringing Out The Best In People

The principles involved here reflect on everyday dealings with people. When you bring out the best in people, you merely teach them to be what they can be. This is what coaching is all about. You detect a given potential in individuals, teach them to believe in themselves, they begin to work and eventually arrive at their dramatic moment.

Whatever the setting, be it the practice field, a one on one situation, an office visit, or in the classroom, I have looked for the strengths and weaknesses in all my athletes as we have discussed their activities. We have talked about their total life sphere during the four or five years on campus. We have talked about friendships, teammates, academics, and problems. I have always learned something about the athlete that would help me establish a good sound relationship with him/her for the years ahead. The more I learned about them, the more I expected good things from them. They knew it and were constantly showing their best side.

"Think of what you've done in the past as an athlete and as a human being. Think of your strengths and your weaknesses. Don't be afraid to go the extra mile—for your family, for your team, for your school."

Coach Vigil at team meeting

The mastery of finding the good side of people is an art. You have to work at it constantly. At Adams College, we built on this art as a team. I conveyed this attitude to our team members so they could practice the same thing.

There are a lot of programs where coaches continue to speak of the bad in their athletes and continue to watch for the worst. Under these circumstances, people get defensive and the doors to inner possibilities close very quickly. People

working together must always have great expectations of themselves and of each other. They must work at developing positive attitudes.

As we got to know each other, there was always a personal relationship established between my athletes and myself. When we both felt this, a strong bond of loyalty was established. We developed lasting friendships that endured for many years after these athletes left campus.

There are many coaches and parents who continually tell their athletes "You have great potential, but you are not living up to it." This type of attitude leaves the athlete feeling as though his character had been attacked. Athletes have to be treated as though they are already at the point where their potential ought to be. Then the coach and athlete can work together to exceed the athlete's present ability and attain his/her full potential. Always concentrate on the athlete's strengths and not their weaknesses.

Coaches must be able to recognize ability. I have always operated under the philosophy that, no matter how bad a person appears, there is always some good in them. This goodness that I detect can be transferred into some type of ability-building. The athlete begins to believe in him/herself for the first time, and all the buried talents begin to surface.

"Teach and live a lifestyle of excellence. Don't be satisfied as a coach with mediocre efforts – Christ taught through the exemplar method."

Coach Vigil at team meeting

I established his type of relationship with a young man who had run a 4:53 mile in high school. What kind of collegiate success would you expect a 4:53 miler to have? Amazingly, by practicing the tenants I have mentioned, this young man went on to become the National Indoor Mile Champion three years running. He eventually posted a lifetime best of 4:01:7 in the mile simply because of the relationship that had been established and my being able to detect his hidden ability. His potential had been suppressed all through high school because of uncaring coaches.

The skill of recognizing ability in someone is rare. Few coaches have this quality. All coaches can develop it. All people have extraordinary talents but few can accomplish extraordinary things unless positive relationships are established.

The advantage of living in a small community and attending a small institution (3,000 students) is that it allows the athlete and coach to have several encounters during the day, in addition to the main training lesson. In many larger schools it isn't possible for these chance meetings to take place. It has given me, as the coach, an opportunity and the environment to discover the many gifts that my athletes have possessed. It has given them an opportunity to discuss the important issues on a one-on-one basis.

I believe that there are two kinds of success in life. One is a rare kind that comes to the person who has the power to do what no one else can do. That is genius, such as in establishing a national or world record or accomplishing some great feat or deed. The second type of success is when the person has ordinary abilities but shares them with his/her friends or team mates.

Emerson once wrote "No one wants to be a failure." Everyone wants to succeed. Most people feel that they have a greater possibility than their present point. However, sometimes there are many missing ingredients. Specifically, the ones addressed in this chapter. I have discovered over the years that, in the soul of everyone, there is an inner drive to achieve something, to be somebody. These desires are nothing more than an entry level for any coach to do his thing.

To be able to tap into this drive is to develop the success of genius. If the coach can make athletes see this, they will do almost anything within their power to live up to the coach's expectations. They will begin to work harder than ever before. The puzzle for the coach has been solved. At this point you have captured the athlete's imagination. Now, anything is possible, including the success of genius.

As runners mature into accomplished athletes, they are able to define the moment in a race when they know they can go on and win. They are able to seize the moment by giving an unusually intense effort from the heart. As a coach over a 30 year span, I have seen many significant efforts, and the truly great ones stand out. Whatever these stakes are in a competition, the sudden and confident shift in behavior announces the defining moment, the time to win. The trademark of a true athlete is one who knows how to get the job done at the moment of truth. To display this type of performance, athletes must show not only courage, but heart and will. They have to constantly display an attitude that leads to success.

As Damon Runyon once said, "You can become a winner only if you are willing to walk over the edge." An athlete must learn the price of hard training over the years. He/she must learn to piece the jigsaw puzzle of periodization together in

order for the body to achieve great things. It is not only the love of the sport, or the love for the team, or desire for success. It is the power of the attitude you have to develop. As great coaches and leaders in any human endeavor have learned; somewhere, some place, some time, you are going to have to stand for some principles, beliefs, and values. You will have to be firm and make a point about who you are and what you stand for. So an athlete must develop the proper attitude. In closing this book, I would like to share with you what Charles Swindoll states about the importance of attitude in life.

ATTITUDE

The longer I live, the more I realize the impact of attitude on life. Attitude, to me, is more important than the facts. It is more important than the past, than education, than money, than circumstances, than failures, than successes, than what other people think or say or do. It is more important than appearances, giftedness or skill. It will make or break a company...a church... a home. The remarkable thing is that we have a choice every day regarding the attitude we will embrace for that day. We cannot change our past...we cannot change the fact that people will act in a certain way. We cannot change the inevitable. The only thing we can do is play on the one strength we have, and that is our attitude ... I am convinced that life is 10% what happens to me and 90% how I react to it. And so it is with you ... we are in charge of our attitudes.

- Charles Swindoll

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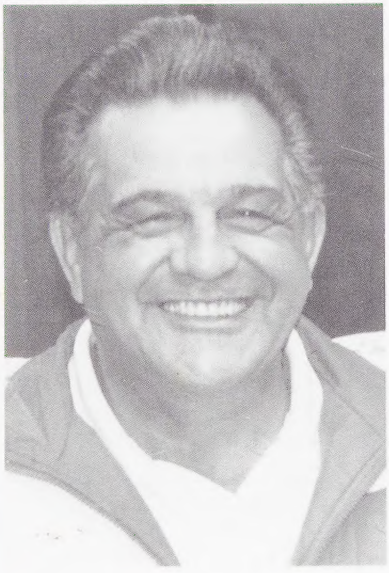
INDEX

Absolute, 18, 23, 41, 143, 163, 200
Acceleration, 83-85, 90, 106, 124-125
Acclimatization, 159, 171-173, 177, 180-184, 186, 189-190
Adams State, *ii-iii, vi, xii,* 2-4, 9, 26, 34, 40, 53, 61, 63, 75, 92, 94-95, 167, 196, 235, 237-238, 241, 244-245
Adaptation, 11-12, 14, 29, 37, 41, 53-54, 60, 72, 84, 90, 101-103, 149, 159, 170, 172-173, 176, 191-192, 194, 197
Aerobic, 14-26, 28, 31, 34-35, 37, 41, 47-48, 63, 65, 67-71, 74-77, 84-88, 90, 93, 95-97, 100-101, 103, 105-106, 112, 115, 118-119, 121, 123, 127, 129-130, 132, 145, 147-148, 156, 160, 166, 172, 177, 183
Aerobic System, 14-15, 17, 26, 31, 69, 74
Aerobic Threshold, 19, 22, 34, 68
Altitude, *viii, x,* 27, 58, 76, 94, 121-122, 135, 157-179, 184
Amortization, 211
Anaerobic, 10, 14-19, 21, 24-26, 30-31, 33-34, 37, 41, 63, 65, 67-71, 75, 77, 85-88, 90, 93, 95-96, 98, 101, 103, 106, 110, 112, 115, 118, 129, 132, 137, 144-145, 148, 155, 166, 168-170, 172, 177, 183, 200
Anaerobic Systems, 25
Anaerobic Threshold, 10, 15, 17-19, 21, 24-26, 33-34, 37, 41, 68, 85-86, 98, 110, 112, 129, 144, 148, 155
Anderson, John, 101
ATP, 14-15, 19, 42, 68, 142, 160, 183
Attitude, *vii, x,*1, 6, 94, 236, 245-249
Barclay, Captain, 136
Barometric Pressure, 160-163, 179
Base, *x,* 18, 23-24, 35, 43, 46-47, 51, 70-71, 73-75, 77, 81-82, 87, 90, 93, 97-98, 100, 102, 109-110, 112, 115, 118, 120, 168-169, 203, 212, 232
Base Phase, 35, 70, 73, 98, 100, 102, 110
Beata, Al, 9
Bedford, Dave, 140
Bell, David, 61
Binks, Joe, 137
Blazek, Brian, 61
Bompa, Tudor, 35
Carbohydrates, 14-17, 19, 42, 68, 113, 142-145, 183
Cardiac Output, 69, 71, 162, 164-165, 183-184
Castillo, Phillip, 237
Ceruty, Percy, 1
Clayton, Derek, 139
Coaching, *iii-vi, viii, ix, ii,* 2, 9-10, 27, 35, 42, 58-59, 64, 71, 95, 101, 118, 136, 167, 237, 245-246
Coe, Peter, *iv,* 6, 19, 70, 110
Core Temperature, 180, 182-184, 191-192
Counsilman, James "Doc", 1
Daniels, Jack, 10
de Castella, Robert, 140
de Mar, Clarence, 137
Dehydration, 159, 172, 180, 185-186, 188
DeLeo, Frank, 61
Dick, Frank, 35
Donley, Julie Jenkins, 91
Dynamic, 200-202, 225, 236, 242
Edelen, Leonard "Buddy", 138
Effort, 3, 15-19, 21, 24-25, 35, 76, 78-79, 97-100, 103, 110, 113, 120-122, 127, 131, 144, 148-149, 175, 212, 238, 244, 248
Elastic, 198, 200, 209-210, 218
Electrolyte, 186, 188
Electrolytic, 186, 190
Endurance, 9-10, 14, 19-20, 28-32, 47-48, 67-69, 75, 78, 81-82, 84-86, 90, 103, 107, 118, 120-125, 138, 144-149, 156, 159, 168-170, 173, 175, 177, 183-186, 188, 190, 192, 198-203
Energy Systems, *x, 10,* 14, 19, 33, 68, 70, 75, 96, 117, 135
Ergogenic Drinks, 188
Erythropoietin, 166
Fartlek, 99, 101, 110, 122, 149, 175
Fast Endurance Run, 120
Fast Twitch, 28-30, 75, 103, 110, 118, 132
Fat, 31, 143-146, 154, 156, 181, 192
Flexibility, *xi,* 40-41, 65, 107, 148, 197-198, 212, 225-228, 230-233
Free Fatty Acids, 19, 68
Fuel, 135, 142-144, 149
Gambetta, Vern, 9, 72
George, Walter, 136
Glucose, 142-145, 188-189
Glycogen, 30-31, 41, 103, 119, 142-145, 149, 156, 183, 189
Glycolytic, 30
Goals, 1-2, 39-40, 50-51, 57-58, 60, 72, 74, 85, 112-113, 115, 118, 138, 149, 204, 212, 235-237, 239-240, 243-244
Golgi Tendon Organs, 211-212
Grahm, Peter, 196
Hameda, Coach T., 158
Hamilton, Brutus, 1
Harre, Dietrich, 35
Hayes, Woody, 1
Heart Rate, 21-22, 26-27, 34, 41, 43, 68-71, 74, 79, 98, 109, 164-165, 183, 192
Hematocrit, 165
Hemoglobin, 69, 118, 162, 165-166
Hormone, 12-13, 143, 166
Hydration, 159, 186, 190
Hyperthermia, 180, 182-183, 185-186, 190
Hypoxia, 160, 162, 168, 170, 177
IAAF, *ix,* 9, 93-94
Ikaanga, Juma, 158
Indicators, 19, 42
Individualization, 50-51
Intelligence, 5-6, 53, 56, 86, 89
Janssen, David, 145
Johns, Martin, *xii,* 61

Jones, Steve, 140
Kearny, J. T., 94
Key Date, 40, 43, 129
Kolehmainen, Hannes, 137
Lactate, 16, 19, 21-22, 25-28, 34, 68, 71, 82, 113-114, 119, 130-131, 137, 145, 164, 166-167
Lactic Acid, 14-18, 25-26, 41, 43, 71, 103, 119
Lombardi, Vince, 1
Lopes, Carlos, 55, 141
Maas, Dan 116, 195
Macrocycle, 37, 39, 44, 51
Marathon, *vii, ix,* 48, 64, 68, 72, 135-152, 154-159, 167-168, 178
Martin, David, 19, 61, 110
Matveyev, L., 35
Mechanics, 64, 66
Medium Endurance Run, 120
Mental Toughness, 118, 236, 241-242, 244
Mesocycle, 37-40, 45-47, 51, 78
Metabolism, 17, 19, 25, 67, 145-146, 148-149, 154, 156, 168, 183, 191-193
Microcycle, 18, 24, 37-38, 41, 45, 51, 85, 97-99, 102, 109-112, 115, 128, 132, 149, 154-156, 176
Mechanics, 64, 66
Mind-Body, 53
Mohr, Jason, 116
Moorcraft, David, 55
Muscle Fibers, 28-29, 119, 209-210
Muscle Spindle, 210-211
Myoglobin, 30-31, 162, 167
Neuromuscular, 12, 41, 44, 65, 67, 149, 169, 191, 209-212
Noakes, Tim, 136
Nurmi, Paavo, 137
Optimum, 65
Overdistance, 47-51, 98
Overload, 10-11, 212, 231, 233
Partial Pressure, 160-161, 179
Peak, *x,* 35-36, 45-46, 48-51, 95, 106, 149, 156
Periodization, *vii, x,*4, 35-38, 40-48, 50-51, 75, 94, 197, 248
Peters, Jim, 138
Philosophy, *v, vii, ix,*1-2, 4, 6-8, 55, 102, 115, 117, 131-132, 138, 156, 237, 240, 247
Phosphogens, 14-17
Plyometrics, 198, 200, 209, 232-233
Precompetitive, *x,*70-81, 84-85, 95-97, 109-112, 115, 128, 203
Preparation Phase, 39, 43-45, 74-75
Prestretch, 209, 211
Race Pace, 25, 27, 48-51, 68, 79-80, 86, 88, 105, 113-114, 124, 126, 130, 147, 149, 154-156
Racing Tactics, 56, 86, 88, 90, 112, 117, 130, 132
Recovery, 13, 15-16, 26, 35, 40-42, 44-47, 50, 53, 55, 71, 74, 79-86, 101-103, 109-112, 119, 122, 127-128, 138, 149, 154, 156, 168, 171, 175, 177-178, 203, 212
Recruitment, 28, 30-31, 110, 119, 132, 149
Regeneration, 172-173, 175-176
Riley, Pat, 244
Relative, 17, 36-37, 44, 65, 103, 167, 180, 184, 200
Relative Humidity, 184
Robirds, Rick, 133-134, 239
RPT, 72, 79, 90
Reference Point Training, 72, 79, 90, 104
Running Economy, 10, 20, 26-29, 33, 37, 113, 137
SAID, (Specific adaptation impose demand) *iv,* 72, 79, 90-93,240,248
Shorter, Frank, 139
Shrubb, Al, 137
Slow Endurance Run, 120
Slow Twitch, 10, 28-30, 118, 129
Smith, Maurice, 92
Steeplechase, *vii, ix,* 93-94, 96, 98-100, 102, 104, 106-116
Strategy, 39, 113-114, 185
Strength, *vi, x-xi,* 5, 10, 29, 40, 53-54, 65, 76-78, 81, 84-86, 102, 106-107, 125, 135, 147-149, 156, 159, 172, 176, 183, 190, 197-201, 203-204, 209, 212, 218, 228, 233, 249
Stress, 11, 19, 25-26, 37, 40, 42, 44-47, 50-51, 100, 131, 143, 170, 176, 183, 191-192, 230
Stroke Volume, 79, 162, 164-165
Subdistance, 48-50
Success, *v, vii, ix,* 1-3, 5-6, 16, 25, 36, 53-56, 58, 60, 62-63, 93-95, 103, 113, 131, 138-139, 141, 176, 179, 197, 235-238, 240, 242, 246-249
Swindoll, Charles, 249
TAC, *iv, viii,* 9, 136
Tactics, 16, 56, 63, 86-90, 112, 117, 130, 132
Technique, 9, 29, 63-64, 72, 75, 96, 106-108, 115, 148, 198, 200, 212, 218, 233, 242
Tests, 39-40, 42, 225
Training Effect, 74
Training Loads, 10, 12-13, 33, 53-54, 71-72, 169, 177
Training Phase, 42, 77-78, 98-99, 103, 173, 176
Training Unit, 13, 39-42
Transition, *ix-x,* 39, 43-44, 46-48, 51, 101, 147-148
Triglyceride, 30-31, 143
USATF, *viii,* 9, 35, 136
Utilization, 16, 18, 20, 24-26, 63, 65, 118, 132, 142-144, 146, 154, 156, 166, 183
Values, *ix,* 1-2, 18, 20, 24, 165, 237, 249
Van Handel, Peter, 10
Variables, 10, 18-22, 36, 45, 79, 82, 95
Velocity, 12, 21-23, 25, 30, 81, 100, 111, 119, 129-130, 144, 193, 199, 210
Ventilation, 113, 164
VO_2 max, 10, 16, 18-21, 23-28, 33-34, 41, 69, 71, 81, 100, 103, 112, 114, 119, 130, 137, 144, 164-165, 185, 189, 192
Volume, *x,* 10-11, 18, 20, 23-24, 27, 36, 42, 44-47, 63, 69-70, 72-76, 79, 85, 90, 105, 118, 126, 129, 137-143, 147-149, 153-156, 162-165, 169-173, 176, 185-186, 192, 212, 218
Walton, Gary, 1
Winckler, Gary, 9
Wooden, John, 1
Yifter, Miruts, 55, 120
Zatopek, Emil, 3, 138-140, 156



Coach Joe Vigil

About the Author:

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